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February 26, 2019

NOTICE OF ADDENDUM
ADDENDUM NO. 1
CONTRACT NO. 8119
S. BRYAN STREET, DALEY DRIVE, JAMES STREET AND THORP STREET
RECONSTRUCTION DISTRICT – 2018

Revise and amend the contract document(s) for the above project as stated in this addendum, otherwise, the original document shall remain in effect.

SPECIAL PROVISIONS:

DELETE THE METHOD OF MEASUREMENTS SECTION UNDER THE HEADING BID ITEM 90033 – CANOE/KAYAK LAUNCH AT JAMES STREET AND REPLACE WITH THE FOLLOWING:

The Canoe/Kayak Launch at James Street will be measured as a Lump Sum, acceptably completed.

DELETE THE ENTIRE ARTICLE 1000 SANITARY SEWER STATION SPECIAL PROVISIONS AND REPLACE WITH THE NEW ARTICLE WITHIN THIS ADDENDUM.

Changes to the original Special Provisions are indicated in RED text.

PROPOSAL:

See below for a summary of items that have been removed, added or revised. Refer to the proposal for updated quantities. See proposal on bidexpress.com.

ITEMS:

Action	Bid Item	Description
NEW	21110	TERRACE RAIN GARDEN
REVISE	70002	FURNISH AND INSTALL 6-INCH PIPE & FITTINGS
REVISE	70031	FURNISH AND INSTALL 6-INCH WATER VALVE
REVISE	70040	FURNISH, INSTALL AND SALVAGE HYDRANT

PLANS:

Title Sheet: Update index of sheets.
RG-1 & RG-2: Rain Garden Plans, new sheets.
LS-3: Revised lift station foundation and location of antenna tower.
LS-6: Revised key notes and lift station foundation.
LS-7: Revised lift station foundation section 1/LS-7. Revised removable post mounted detail 2/LS-7. Removed toe-plate and revised post to go over top of mounting plate vertical member. Revised guardrail elevation detail 3/LS-7. Changed diameter elevation of guardrail. Remove typical slab on grade detail 5/LS-7.

LS-9: Revised lift station foundation and location of antenna tower.
LS-14: Revised electrical plan notes.
LS-15: Revised note 8 for owner furnished antenna equipment and deleted station hand/auto and start/stop push button.
LS-16: Added note to generator to ground per NEC code.
LS-17: Deleted station hand/auto. Deleted start/stop push buttons. Added pilot lights.
LS-18: Revised conduit and box schedule.
LS-21: Revised generator pad detail. Revised free standing control panel detail.
LS-22: Revised antenna base.
W-7: An additional fire hydrant and associated fittings have been added to the 3000-block of Thorp Street.
W-10: Updating material estimates based on changes to sheet W-7.

Please acknowledge this addendum on page E1 of the contract documents and/or in Section E: Bidder's Acknowledgement on Bid Express.

Electronic version of these documents can be found on the Bid Express web site at:
http://www.bidexpress.com

If you are unable to download plan revisions associated with the addendum, please contact the Engineering office at 608-266-4751 receive the material by another route.

Sincerely,

Robert F. Phillips, P.E.
City Engineer

RFP:AJZ

ARTICLE 1000 SANITARY SEWER LIFT STATION SPECIAL PROVISIONS

SECTION 01 45 00

QUALITY CONTROL

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. Applicable provisions of the City's Standard Specifications shall govern work of this section.

1.02 APPLICABLE PUBLICATIONS (NONE)

1.03 DESCRIPTION OF WORK

A. Provide quality control for all work performed under this contract as described in this section.

1.04 RELATED WORK ELSEWHERE

A. Structural Excavation for Structures – Division 31

1.05 SUBMITTALS (NONE)

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

1.07 QUALITY ASSURANCE

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform work by persons qualified to produce workmanship of specified quality.

F. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.08 TOLERANCES

A. Monitor tolerance control of installed products to produce acceptable work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.09 REFERENCES

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard by date of issue current on date of Contract Documents, except where a specific date is established by code.

C. Obtain copies of standards where required by product specification sections.

D. The contractual relationship, duties, and responsibilities of the parties in Contract nor those of the Engineer shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.10 INSPECTING AND TESTING LABORATORY SERVICES

A. Contractor shall be responsible for concrete testing as outlined in Section 01 45 16.11 and Division 03 of these specifications. For other testing not related to defective work issues, Owner will appoint, contract, and pay for the services of an independent firm to perform inspecting and testing.

B. Geotechnical services and soil testing shall be required to meet performance requirements specified in Divisions 31, and 33 and in other Sections related to this work. Geotechnical services and soil testing shall be procured and paid for by the Owner.

C. The independent firm will perform inspections, tests, and other services specified in individual specification sections and as required by the Engineer or the Owner.

D. Inspecting, testing, and source quality control may occur on or off the project site. Perform off-site inspecting or testing as required by the Engineer or the Owner.

E. Reports will be submitted by the independent firm to the Engineer indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

F. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
   1. Notify Engineer and independent firm 24 hours prior to expected time for operations requiring services.
   2. Make arrangements with independent firm and pay for additional samples and tests required for Contractor's use.

G. Testing or inspecting does not relieve Contractor from the responsibility to perform Work to contract requirements.

H. Retesting required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by the Engineer. Payment for retesting will be charged to the Contractor by deducting inspecting or testing charges from the Contract Sum/Price.

1.11 MANUFACTURERS' FIELD SERVICES AND REPORTS

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, and test, adjust and balance of equipment as applicable, and to initiate instructions when necessary.

B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

C. Submit report within 30 days of observation to Engineer for information.

PART 2 PRODUCTS AND MATERIALS (N/A)

PART 3 CONSTRUCTION METHODS (N/A)

PART 4 MEASUREMENT AND PAYMENT (N/A)

END OF SECTION

SECTION 01 45 16.11

CONCRETE QUALITY CONTROL

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. The work under this section shall cover sampling and testing of concrete to determine the materials conformance and work conformance to the requirements specified for cast-in-place concrete.

1.02 RELATED WORK ELSEWHERE

A. Concrete Accessories - Division 03

B. Cast-in-Place Concrete - Division 03

1.03 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern work of this section.

1.04 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards:
    a. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field, Current Edition.
    b. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens, Current Edition.
    c. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete, Current Edition.
    d. ASTM C78 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading), Current Edition.
    e. ASTM C114 - Standard Test Methods for Chemical Analysis of Hydraulic Cement, Current Edition.
    f. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete, Current Edition.
    g. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete, Current Edition.
    h. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method, Current Edition.

i. ASTM C183 - Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement, Current Edition.
j. ASTM C186 - Standard Test Method for Heat of Hydration of Hydraulic Cement, Current Edition.
k. ASTM C187 - Standard Test Method for Normal Consistency of Hydraulic Cement, Current Edition.
l. ASTM C188 - Standard Test Method for Density of Hydraulic Cement, Current Edition.
m. ASTM C192 - Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory, Current Edition.
n. ASTM C219 - Standard Terminology Relating to Hydraulic Cement, Current Edition.
o. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method, Current Edition.
p. ASTM C470 - Standard Specification for Molds for Forming Concrete Test Cylinders Vertically, Current Edition.
q. ASTM C823 - Standard Practice for Examination and Sampling of Hardened Concrete in Constructions, Current Edition.
r. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection and/or Testing, Current Edition.

PART 2 PRODUCTS AND MATERIALS (N/A)

PART 3 CONSTRUCTION METHODS

3.01 TESTING FOR ACCEPTANCE

A. Samples of concrete shall be delivered to a location on the site where material conformance tests can be performed.
1. Samples of concrete shall be obtained in accordance with ASTM C172.
2. Test specimens shall be stored without being disturbed for the first 24 hours.
3. Sampling and Testing. An independent testing laboratory, engaged and paid for by the Owner, shall conduct tests on the proposed concrete mixture to determine the slump, entrained air content, compressive strength, or other appropriate tests to determine conformance with these specifications.

B. Contractor shall cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
1. Notify Engineer and independent firm 24 hours prior to expected time for operations requiring services.
2. Make arrangements with independent firm and pay for additional samples and tests required for Contractor's use.

C. Slump and Air Content Tests

1. Slump tests shall be made in accordance with ASTM C143. Air content tests shall be made in accordance with ASTM C173 or ASTM C231. Slump tests and air tests shall always be performed from the same batch from which strength tests are performed.
2. If the measured slump or air content falls outside the limits specified, a check test shall be made immediately on another portion of the same sample. In the event of a second failure, the concrete shall be considered to have failed to meet the requirements of the specifications and shall not be used in the work.

D. Strength Tests (Contractor's Sampling and Testing for Acceptance). Results from tests conducted by the Contractor shall be considered evidence of compliance of Contractor's materials used in the work, when strength is used as the basis for acceptance.
1. Cylinders for strength tests shall be made in accordance with ASTM C31. During the first 24 hours all test specimens shall be covered and kept at air temperatures between 60 Degrees Fahrenheit and 80 Degrees Fahrenheit in facilities provided on the job site by the Contractor. At the end of 24 hours, specimens will be carefully transported to the testing laboratory, where molds shall be removed, and cylinders shall be cured in a moist condition at 73.4 Degrees Fahrenheit ±3.0 Degrees Fahrenheit until time of test.
2. A strength test for any class of concrete shall consist of four standard cylinders made from a composite sample secured from a single load of concrete in accordance with ASTM C172, with one cylinder tested at 7 days, two at 28 days, and the fourth used as a spare. The test results at 28 days shall be the average of the strength of two specimens determined in accordance with ASTM C39, except that if one specimen in a test shows manifest evidence of improper sampling, molding or testing, it shall be disregarded and the spare cylinder shall be tested.

E. Strength Test (For Early Formwork or Shoring Removal). If the Contractor wishes to remove formwork or shoring prior to the minimum time as specified in Structural Cast-In-Place Concrete Forming - Division 03, they shall, at their expense, prepare test cylinders as evidence of concrete strength as follows:
1. Cylinders shall be made in accordance with ASTM C31. During the period of time from completion of the pour to removal of protective cover and stripping of forms, all test specimens shall be kept with the pour and be subjected to ambient conditions resulting from the curing and protection facilities provided on the job site by the Contractor. At the end of this period, specimens will be carefully transported to the testing laboratory, where molds shall be removed and cylinders shall be stored in outdoor ambient conditions to simulate on job site conditions until time of test.
2. A minimum of two cylinders made from a composite sample secured from a single load of concrete in accordance with ASTM C172. The test results shall be the average of the strength of two specimens determined in accordance with ASTM C39, except that if one specimen in a test shows

manifest evidence of improper sampling, molding or testing, it shall be disregarded.

3.02 SELECTION OF TESTING LABORATORY

A. An independent testing laboratory to perform Concrete Quality Control shall meet the requirements of ASTM E329. The laboratory shall be selected by the Owner.

3.03 TEST REPORTS

A. Test reports will be directly distributed by the laboratory to the Owner, Engineer, and Contractor.

3.04 TESTING REQUIREMENTS

A. Tests shall be required to perform one test for each 50 cubic yards of concrete poured, or fraction thereof, for each class of concrete used. Each test shall consist of four (4) cylinders; one (1) to be tested at seven (7) days, two (2) to be tested at twenty-eight (28) days, and one (1) to be a spare.

B. Compliance testing shall be performed on every single load, or portion thereof, where water addition to the single load, or portion thereof, takes place on site.

C. A minimum of one (1) test shall be performed per day for each class of concrete placed.

3.05 CONDITIONS OF COMPLIANCE AND NON-COMPLIANCE

A. <u>Compliance of Contractor's Materials Used in the Work.</u>

1. To conform to the requirements of this specification, every 28-day test representing each mix must be equal to or greater than the specified minimum strength without exception. If a specimen shows manifest evidence of improper sampling, molding, or testing, it will be disregarded. Note, however, that the anticipated strength for all mixes is appreciably above the specified minimum strength due to quality required by the water-cement ratio specified.

B. <u>Non-Compliance of Contractor's Materials Used in the Work</u>

1. When strength is used as the basis for acceptance, should individual tests of the Contractor's specimens produce strengths less than 90% of the specified strength (f'c), tests of cores drilled from the area in question may be required in accordance with ASTM C42. Three cores shall be taken for each cylinder test less than 90% of the specified strength (f'c). If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60 to 80°F, relative humidity less than 60 percent) for seven (7) days before test and shall be tested dry. If the concrete in the structure will

be more than superficially wet under service conditions, the cores shall be immersed in water for at least 48 hours and tested wet.

2. Concrete represented by the core tests will be considered structurally adequate and meet the requirements of this specification if the average of the three cores is equal to at least 95 percent of the specified strength (f'c) and if no single core is less than 90 percent of f'c. To check testing accuracy, locations represented by erratic core strengths may be retested. If these strength acceptance criteria are not met by the core tests, the Engineer shall order appropriate action at no additional cost to the Owner.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. All work specified herein shall be considered in the measurement and payment method stipulated.

4.02 CONCRETE QUALITY CONTROL

A. Concrete Quality Control, Inclusive. All required sampling, preparing of specimen and testing, except as modified by these specifications shall be performed by an independent testing laboratory engaged and paid for by the Owner. Contractor shall assist the independent laboratory by making the site and sampling locations accessible for the specified testing. All costs shall be inclusive to the lump sum bid item for the Lift Station.

B. Additional Testing.

1. The cost of any additional testing required because of failure of concrete to meet specification requirements shall be borne by the Contractor for tests which fail to comply with the specifications. All tests required under Paragraph 3.05 "Conditions of Compliance and Non-Compliance", above shall be borne by the Contractor.

END OF SECTION

SECTION 01 73 00

EXECUTION

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS (NONE)

1.03 DESCRIPTION OF WORK

A. The Work included under this section is related to the replacement of the James Street Lift Station as specified herein.

B. The Contractor shall be responsible for performing the work according to a sequence of construction that will not adversely affect the continued operation, performance, or reliability of the sewage conveyance systems and related systems during construction. The Contractor shall provide temporary facilities, including bypass pumping equipment and bypass piping as necessary to ensure that the existing sewage conveyance system continues to provide service required during the construction of the new facilities. If interruption of sewage conveyance systems or power outage is proposed/required, the Contractor shall provide temporary facilities to replace the disrupted operations.

1. The Contractor will be responsible to provide and operate all temporary pumps, automatic controls, equipment, and temporary piping to maintain operation of the existing wastewater conveyance facility during construction and implement phased construction in the recommended sequence.

C. The Work includes selective demolition and the replacement of the existing Lift Station, controls, electrical services, sanitary sewer, force main, various equipment and piping, along with the demolition of the existing structures, and the construction of new structures, equipment and piping that will impact the operation of the existing facilities.

D. Contractor shall provide manpower, labor, and equipment as needed to implement the start-up of newly constructed and modified facilities and implement the shutdown of existing facilities one-at-a-time prior to construction modifications.

1.04 RELATED WORK ELSEWHERE

A. All Sections of this Project Manual

1.05 SUBMITTALS

A. Where the work impacts the operation of the existing facilities and new construction, the Contractor shall submit a detailed sequence of construction and daily schedule

that demonstrates the ability to maintain the necessary reliability and performance of the sewage conveyance system. Where temporary facilities are required, the Contractor shall submit detail of the equipment and materials that will be provided to ensure the reliability and performance of the facilities.

1.06 CRITICAL DELIVERY OF EQUIPMENT AND MATERIALS

A. No extra time or additional costs will be allowed by the Owner for any cause for delay in the delivery of products, materials, and equipment required in this Project.

1.07 OPERATION/MAINTENANCE MANUALS AND INSTRUCTION (NONE)

PART 2 PRODUCTS AND MATERIALS (N/A)

PART 3 CONSTRUCTION METHODS

3.01 SEQUENCE OF CONSTRUCTION

A. The following sequence of construction is included as a guide for the Contractor for construction of the lift station and forcemain. Contractor may need to consider other factors in the overall sequence and schedule that are not discussed in the Section but are specified in the Contract Documents.

B. The Contractor is responsible for their sequence of construction and the construction schedule. The Contractor shall clearly define their intended sequence of construction in the submitted construction schedule. The intent of the following sequence of construction is to ensure the continued performance and reliability of the existing facilities during construction and to ensure the successful start-up of all new facilities. Deviations from the following sequence of construction shall be identified by the Contractor at the Pre-Construction Meeting for discussion and approval by Owner and Engineer.

C. Suggested Sequence of Construction
   1. Removal and Replacement of Sanitary Sewer on East James Street (3100 block)
      a. Remove/Replace Sanitary Sewer beginning at SAS#1 until approximately 17+50. Connect all laterals to new Sanitary Sewer.
      b. Relocate lateral for residence at 3137 James Street
      c. Provide temporary sanitary sewer to connect SAS #1 into existing lift station.
   2. Relocate watermain on James Street
   3. Construct the proposed Forcemain on James Street
      a. Construct proposed forcemain beginning at approximately STA. 15+75 to STA. 22+60.96 including construction of SAS #100.
      b. Install temporary piping and connection for use with bypass pumping equipment at STA. 15+75.

4. Complete remaining utility work as specified in the Contract Documents
5. Install Temporary Bypass Pumping System
    a. Install temporary bypass pumps in SAS #1. A minimum of two (2) pumps shall be utilized including automated operation with a float tree. Contractor shall submit information on pump model, capacity, and proposed layout.
    b. Pumps shall be connected through temporary piping to the new forcemain. Contractor shall utilize quick-connects, isolation valves, and check valves for reliability. Contractor shall submit the proposed bypass piping layout for review by the Owner and Engineer.
    c. Temporary pumping system shall remain in-place until the new lift station is commissioned.
6. Demolish Existing Lift Station
    a. Contractor shall provide a minimum of seven (7) days' notice to the Owner prior to beginning demolition of the existing lift station. Contractor shall disconnect all utilities from existing lift station prior to beginning demolition.
7. Construct new Lift Station
8. Construct remaining proposed forcemain from new lift station to forcemain previously installed to STA 15+75.
9. Start up, and test the new lift station including pumps, controls and standby generator.
10. Discontinue and disconnect Temporary Bypass Pumping System after the new lift station is commissioned.
    a. Commissioning of new lift station shall include all controls, back-up power, monitoring, alarms, and telemetry.

D. Utilities (new water, gas and electric service) associated with lift station and generator structures shall be installed and operational for start-up of new pollution control equipment and prior to abandonment and/or demolition of existing utilities in accordance with the demolition plan.

E. The Contractor shall coordinate all work to be completed without disruption to the collection and pumping of sewage. Contractor shall not cause a sewer system overflow, or back-up of the sewage system. Contractor is responsible for all costs that may be incurred due to a disruption in the collection and pumping of sewage.

PART 4 MEASUREMENT AND PAYMENT

4.01 EXECUTION

A. General. Execution of the project shall be paid for at the bid price in accordance with one of the following methods, unless indicated otherwise in the Bid Schedule or Special Provisions.
1. Execution, Inclusive. All costs associated with execution of the project in a manner that ensures the continued performance and reliability of the sewage

conveyance systems shall be included in the Lump Sum bid price for the Lift Station.

END OF SECTION

SECTION 02 41 16

STRUCTURE DEMOLITION

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. American National Standards Institute (ANSI) Specifications and Standards:
   a. ANSI A10.6 - Safety Requirements for Demolition, Current Edition.
2. Code of Federal Regulations (CFR), Title 29, Chapter XVII - Occupational Safety and Health Administration (OSHA), Department of Labor, Part 1926 Regulations, Current Edition.

1.03 DESCRIPTION OF WORK

A. The work under this section shall cover furnishing all materials, equipment, tools, labor and supervision necessary to remove equipment, adapt for new equipment, and dispose of unused materials as indicated upon contract drawings and as specified herein.

B. Comply with applicable rules, regulations, codes, and ordinances of local, state, and federal authorities including ANSI A10.6, Safety Requirements for Demolition.

C. Contractor shall sequence work to enable uninterrupted operation of the facility to the extent of practical limits, and as determined by Engineer.

1.04 RELATED WORK ELSEWHERE

A. Article 203 – Removal of Miscellaneous Structures

B. Packaged Sewage Lift Station – Division 33

1.05 SUBMITTALS

A. Submit detailed sequence of operation for structure demolition and removal work in accordance with City submittal to ensure minimum interruptions of Owner's operations. Submit timeline indicating removal and placement of proposed equipment.

B. Submit detailed information for weather protection, dust protection, openings required if any in protection walls, sealing system for perimeter of opening and wall.

C. Submit certificates and/or letters as evidence of discontinuation of services to building or structure requiring removal from appropriate agencies and evidence of discontinuation of water or electrical lines used for structure demolition purposes.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

PART 2 PRODUCTS AND MATERIALS

2.01 EQUIPMENT

A. Use normal equipment for structure demolition purposes which meet all safety requirements imposed on such equipment.

2.02 REMOVAL OF ITEMS

A. Items noted to be turned over to Owner shall be delivered to location on property where designated by Owner.

B. Refer to contract drawings and Special Provisions for a list of items to be removed.

2.03 ITEMS FOR STORAGE

A. Items noted for storage shall be delivered to location on site at Contractor's discretion until reincorporated into the Work.

PART 3 CONSTRUCTION METHODS

3.01 GENERAL

A. Conditions existing at time of inspection for bidding purposes will be maintained by the Owner to the extent practicable. Owner shall have the right to salvage any existing equipment and furnishings.

B. Owner assumes no responsibility for subsurface conditions on site. Become familiar with subsurface conditions at the site. Owner assumes no responsibility for actual conditions of structures and appurtenances to be demolished. Become familiar with actual condition of structures and appurtenances.

C. Perform structure demolition work required in connection with this project with due care, including shoring and bracing. Be responsible for any damage which may be caused by such work to any part or parts of existing building which is to remain. Where necessary to prevent collapse of any construction, install temporary shores, struts, or bracing. Do not commence structure demolition work until all temporary construction is complete.

3.02 POLLUTION CONTROLS

A. Use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt rising and scattering in air to lowest level practical. Clean adjacent structures and improvements of dust, dirt, and debris caused by structure demolition operations. Return adjacent areas to condition existing prior to start of the work.

B. Comply with governing regulations pertaining to environmental protection.

3.03 BELOW-GRADE DEMOLITION

A. Demolish and remove below-grade wood, metal construction, and floor construction as directed upon contract drawings. Demolish all abandoned structures to a depth of not less than 24 inches below the existing ground surface, or 24 inches below planned finish grade, whichever is lower.

B. All abandoned structures or tanks which could hold moisture shall have drain holes cut through the bottom, or the structures or tanks shall be otherwise breached to allow moisture to pass.

C. Cap, with appropriate thrust restraint, all abandoned piping and conduit for a complete, permanent abandonment. Provide thrust restraint with a poured concrete reaction block in accordance with the contract drawings.

D. Completely fill below-grade areas and voids resulting from demolition. Use satisfactory soil materials consisting of stone, gravel, and sand, free from debris, trash, frozen materials, roots and other organic matter. Prior to placement of fill materials, ensure that areas to be filled are free of standing water, trash and debris. Place fill materials in horizontal layers not exceeding 6 inches in loose depth. Compact each layer at optimum moisture content of fill material to a density equal to original adjacent ground, unless subsequent excavation for new work is required.

E. Coordinate activities to permit access by other trades required for the work, enabling them to complete work which is assigned to them. Accomplish all work required by contract drawings, including work specifically noted plus additional work related to specific work noted.

3.04 SELECTIVE DEMOLITION

A. Demolish masonry and concrete in small sections. Use braces and shores as necessary to support the structure of the building and protect it from damage. Where limits of demolition are exposed in the finish work, cut with saws, providing a straight line, plumb, true, and square.

B. Disconnect services to equipment at unions, flanges, valves, or fittings. Remove and/or demolish plumbing, mechanical, and electrical components not requiring

salvage or reuse. Remove and/or demolish to penetration point at floor, ceiling, and wall or surface, as applicable. Cut fire electrical systems in such a manner as to insure continued operation of the systems in remaining buildings.

C. Leave exposed existing floor, ceiling, and wall or surface in suitable condition for receiving new finish.

3.05 PROTECTION

A. Make such explorations and probes as necessary to ascertain any required protection measures before proceeding with demolition and removal work. Provide protection for workmen, public, adjacent construction, and occupants of existing building(s). Provide protection for adjacent private property. Promptly repair damages caused to adjacent facilities at no cost to Owner.

B. Provide and maintain adequate catch platforms, warning lights, barricades, guards, weather protection, dust protection, fences, planking, bracing, shoring, piling, signs, and other items required for proper protection.

C. Explosives shall not be used. Use no equipment or methods of operation which will cause damage to adjoining buildings either by direct contact or by transmission.

3.06 UTILITY SERVICES

A. Maintain existing utilities indicated to remain, keep in service, and protect against damage during demolition operations.

3.07 DISPOSAL

A. Remove all disposable material and equipment indicated and properly dispose of at off-site location of Contractor's choice. Storage of disposable materials and equipment on site shall not be permitted.

B. Burning of debris on site is not permitted.

3.08 RESTORATION

A. Restore the site after demolition operations are complete.

B. Restore interior and exterior building surfaces with similar materials and to a condition equal to or better than previously existed. Refer to the finish schedules of the contract drawings and specifications for materials and finishes specified.

C. Restore site with similar materials, and to a condition equal to or better than previously existed. Perform grading in accordance with final grading requirements as indicated on the contract drawings.

1. Grading tolerances shall be as indicated in contract drawings and City specifications.
2. Restore turf areas disturbed.
3. Restore pavement or sidewalk areas disturbed.

D. Provide temporary erosion control measures until such time as permanent restoration no longer requires these measures, and as directed by the Engineer.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Structure demolition shall be paid for at the bid price in accordance with one of the following methods, unless indicated otherwise in the Bid Schedule or Special Provisions.

B. All work specified herein shall be considered in each of the measurement and payment method(s) stipulated, unless indicated otherwise in the Bid Schedule or Special Provisions.

4.02 STRUCTURE DEMOLITION

A. Structure Demolition, Inclusive. Structure demolition related to the Lift Station as shown on the contract drawings and as outlined in the Project Manual shall be considered inclusive to payment for work associated with Sanitary Sewer Lift Station, per Lump Sum.

END OF SECTION

SECTION 03 11 13

STRUCTURAL CAST-IN-PLACE CONCRETE FORMING

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. The work covered under this section shall consist of furnishing all materials, equipment and labor required to furnish all formwork for cast-in-place concrete as shown on the contract drawings and specified herein.

B. The work shall include formwork, shoring for cast-in-place concrete, and installation into formwork of items by other such as anchor bolts, setting plates, bearing plates, anchorages, inserts, frames, nosings and other items to be embedded in concrete.

1.02 RELATED WORK ELSEWHERE

A. Concrete Accessories - Division 03

B. Concrete Reinforcing - Division 03

C. Cast-in-Place Concrete - Division 03

1.03 APPLICABLE PROVISIONS (NONE)

1.04 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. American Concrete Institute (ACI) Annual Book of ACI Standards:
   a. ACI 117/177R - Specifications for Tolerances for Concrete Construction and Materials and Commentary, Current Edition.
   b. ACI 347 - Guide to Formwork for Concrete, Current Edition.
   c. ACI SP-4 - Formwork for Concrete, Current Edition.
2. American Plywood Association (APA) Specifications and Standards:
   a. APA PS1 - Plywood Design Specification, Current Edition.

PART 2 PRODUCTS AND MATERIALS

2.01 DESIGN

A. The design and engineering of the formwork and its accessories shall be the responsibility of the Contractor. Formwork shall be designed, erected, supported, braced and maintained so as to safely support all vertical and lateral loads until such loads can be supported by the concrete structure.

B. Determination of loads and design shall be in accordance with ACI 301 and ACI 347.

2.02 FORMS

A. Forms may be wood, plywood, concrete-form-grade hardboard, metal or other acceptable material which will produce smooth, true surfaces.
   1. Provide lumber dressed on at least two edges and one side for tight fit.
   2. Metal forms shall have smooth surfaces free from any pattern, irregularities, dents, bends and sags.

2.03 SHORING

A. All shoring members shall be of such design and material to safely support all dead and working loads throughout the placing and curing period. Shoring shall be placed to prevent sagging and settlement.

2.04 FORM TIES AND ACCESSORIES

A. Form ties shall be factory-fabricated, adjustable-length, removable or snapoff metal, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal.

B. For exposed concrete surfaces, provide ties so that the portion remaining with the concrete after removal is 1 inch to 1-1/2 inches inside the finished face of the concrete.

C. Unless otherwise indicated, provide form ties which will not leave holes larger than 1 inch in diameter in concrete surfaces.

2.05 FORM COATING COMPOUND

A. Form coating compound shall be a commercial formulation that will not bond with, stain, nor adversely affect concrete surfaces and not impede the wetting of surfaces to be cured with water or curing compounds. Forms for concrete surfaces requiring subsequent treatment shall receive a type of coating that will not impair bond or adhesion.

B. Form coating compound for steel forms shall conform with all requirements stated above and shall be of rust-preventative type.

PART 3 CONSTRUCTION METHODS

3.01 GENERAL

A. <u>Responsibility.</u> The design and construction of formwork shall be the sole responsibility of the Contractor.

B. Earth forms are not acceptable or permitted.

C. Construct forms to the exact sizes, shapes, lines and dimensions shown, as required to obtain accurate alignment, location, grades, level and plumb in finished construction and to maintain tolerances in accordance with ACI 301. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required. Chamfer all corners of concrete exposed to view using chamfer strips. Use selected materials to obtain required finishes.

D. Forms shall be sufficiently tight to prevent leakage of concrete. Temporary openings shall be provided in the inside form of all wall forms and in column forms to facilitate cleaning and inspection immediately before placing concrete.

E. Assemble forms so their removal will not damage concrete and adjacent materials.

3.02 FORMWORK

A. Forms shall conform in general to shape, line, grade and dimensions of members as shown on contract drawings, and shall have the strength and stability to insure finished concrete within the tolerances specified in ACI 347.

1. Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from those other trades.
2. Exterior edges of all exposed concrete, unless otherwise specified, shall have a chamfer strip placed in form to provide bevel of sharp edges. Chamfer strips shall be 3/4-inch by 3/4-inch by 45º wood, plastic, or rubber.
3. Accurately place and secure in position, prior to placing concrete, all anchors, bolts, inserts and other items furnished under other sections of the specifications and for other contractors on the project.

B. Formwork shall be mortar-tight and sufficiently rigid to prevent displacement or sagging between supports.

C. Formwork shall be properly braced or tied together so as to maintain position and shape and insure safety to workman and passersby.

D. Temporary openings may be provided on all wall and column forms to limit the free fall of the concrete to less than 4 feet and should be so located as to facilitate the placing and consolidation of the concrete. The ports shall be spaced no more than 6 feet apart to limit the horizontal flow of concrete.

E. All forms shall be cleaned and rubbed smooth prior to placing to insure true forming surfaces for all concrete surfaces.

3.03 FORM TIES AND ACCESSORIES

A. Internal wall ties shall contain positive stops at the required wall thickness. The exterior clamp portions of the pipe shall be adjustable to permit tightening of forms. Ties shall provide a positive disconnection 1 inch to l-1/2 inches inside the finished face of the concrete. Cutting ties back from face of wall or use of wire ties will not be permitted. All tie and plug holes shall be filled with non-shrink grout after forms are removed.

B. All concrete tie locations shall be watertight. Wall ties shall be fitted with tapered rubber plugs at all locations.

C. Accessories shall be used only for the purpose intended and shall in no way interfere with the placing of concrete. Removal of accessories shall in no way impair or disturb finish concrete surfaces. Accessories shall be compatible with formwork and ties and shall maintain the watertight integrity of the formwork system.

D. Design of all form ties and accessories shall be adequate for all concrete placement, horizontal and vertical, to prevent failures and blowouts.

3.04 FORM COATINGS

A. Coat form contact surfaces with form bond breaker compound before reinforcement is placed. Do not allow excess form coating material to accumulate in the forms or to come into contact with surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

B. Coat steel forms with form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

C. Clean reinforcing steel that has become contaminated with form coating to the satisfaction of the Engineer prior to placing concrete.

3.05 EMBEDDED ITEMS

A. Items embedded in concrete shall be properly cleaned to be free from oil or foreign matter that would weaken the bond of the concrete to these items.

B. Install in the formwork requisite inserts, anchors, sleeves and other items specified under other sections of these specifications; close end conduits, piping and sleeves embedded in concrete with caps or plugs.

C. Conduits or pipes embedded in slabs of larger outside diameter than 1-1/2 inches, or when pipes and conduits come closer than 1 inch from either the upper or lower surface of the slab, provide expanded metal or wire mesh laid and extended beyond conduit or piping at least 8 inches on all sides; space conduits or pipes closer than 3

diameters on centers, place to avoid changing locations of reinforcement for indicated locations.

3.06 CONSTRUCTION JOINTS

A. Make construction joints where indicated on the contract drawings; additional construction joints are subject to prior approval of the Engineer; locate additional construction joints to least impair the strength of the structure.

B. Form keyways and joints as indicated on the contract drawings.

C. Continue reinforcing steel and wire fabric across construction joints, unless noted otherwise.

D. Install joint filler at locations indicated on the contract drawings; extend filler from bottom of concrete; joints shall be carefully cleaned, free from dust, mortar or other loose materials before installation; seal as indicated on the contract drawings.

3.07 EXPANSION JOINTS

A. Expansion joints shall be placed where indicated on the contract drawings; reinforcement, corner protection angles or other fixed metal items embedded in or binded to continuously shall not extend through expansion joints; finish concrete slab edges along expansion joints neatly with slightly rounded edging tool; leave joints in the completed work carefully tooled and free of mortar and concrete.

B. Joints between slabs on earth and vertical surfaces, including columns, piers, walls, machinery foundation and other fixed structures shall have expansion joint material placed on abutting vertical surfaces.

C. Joints to receive joint compound shall have premolded expansion filler strips at proper level placed below finished floor with slightly tapered, dressed, oiled wood strip secured temporarily to top thereof; install wood strip of depth to form groove at least 1 inch deep; after concrete has set, remove strip; fill groove with light colored joint compound for poured application; fill joint grooves flush, to be slightly concave, after drying as specified in Joint Sealers - Division 07.

3.08 CONTROL JOINTS

A. Install vertical control joints as indicated on the contract drawings, and where not indicated not more than 20 feet apart; locate specifically as follows:

1. Place not over 10 feet from corners or offsets; where concrete walls change either thickness or height; where change in wall sections occurs.
2. At each control joint, extend only alternate horizontal reinforcement bars through the joint; seal control joints with concrete colored joint compound.

B. Install control (contraction) joints in slabs as indicated on the contract drawings, and where not indicated locate specifically as follows:
   1. Space at a minimum of 25 feet on center; at each joint, cut reinforcing mesh so only alternate wires extend through joint.
   2. Resulting panels shall be approximately square; elongated and L-shaped panels shall not be acceptable.
   3. Provide 1/4 inch wide saw - cut control joints to a depth equivalent to 1/3 the slab thickness; cut as soon as the slab will support the weight of the saw and operator and not damage the surface and not more than 8 hours after completion of concrete placement.

C. Apply joint compound to all control and construction joints after concrete has sufficiently cured; clean joint slot; fill joint with light colored compound for poured application; fill joint grooves flush, to be slightly concave after drying, as specified in Joint Sealers - Division 07.

3.09 FORM/SHORING REMOVAL

A. Arrange forms to allow stripping without removal of principal shores, where required to remain in place.

B. Removal of forms shall be accomplished in such a manner as will prevent injury to concrete and insure complete safety of structure. Removal times listed below are minimum and may be increased by the Engineer as job conditions warrant.
   1. Where structure as a whole is supported on shores, vertical forms such as beam and girder sides, columns, and similar vertical forms may be removed 24 hours after completion of pour, providing concrete has hardened sufficiently to sustain its own weight and to prevent injury.
   2. Wall forms shall not be removed in less than 24 hours after pouring, unless otherwise required for curing.
   3. Supporting forms and shoring must remain in place until concrete can carry any loads to be imposed upon it and in no case shall be removed in less than seven (7) days.
   4. Forms ties, requiring any operation in removal of forms which would tend to destroy bond between tie and concrete in order to remove form, shall not be disturbed for seven (7) days after completion of pour.
   5. The time periods stipulated above may be reduced if strength results of concrete so indicate adequate conditions.

C. Notify the Engineer before the forms are removed in order that an examination of the newly-stripped surfaces may be made prior to patching.

3.10 REPAIR TIE HOLES

A. After removal of form tie, the holes shall be filled as follows:
   1. Thoroughly clean and dampen.

2. Fill solid with patching mortar.

B. Make repairs uniform in color and finish with surrounding concrete.

3.11 EXPOSED SURFACES

A. Exposed surfaces shall be Carborundum rubbed to take off fins; fill pores, stone pickets, honeycombs, etc., with non shrink grout as follows:
   1. Repair immediately after form removal and inspection by the Engineer.
   2. Remove concrete surrounding defect to sound concrete, then wet affected area.
   3. Brush on bonding agent, mixed and applied in accordance with manufacturer's recommendations.
   4. Consolidate patch grout and strike off to leave the patch slightly higher than the surrounding surface.
   5. Finish the repaired area flush with the surrounding area after the patch has been in place for one hour, or as prescribed by the manufacturer.

B. Perform patching before curing compound is applied; cure patched areas in the same manner as adjacent concrete; make repairs uniform in color and finish with surrounding concrete.

C. Exposed surfaces shall be protected from excessive sun, wind and rain, and kept wet until curing compound is applied. When ambient temperature falls below 40ºF heat aggregate and mixing water; clear all forms, reinforcement and subgrade of snow and ice; cover all freshly placed concrete with tarpaulins, and provide heat to maintain a temperature of 70ºF for at least three days or 50ºF for five days; rate of cooling after end of protection period shall be accomplished in a manner approved by the Engineer.

3.12 REUSE OF FORMS

A. Clean and repair surfaces of forms to be re-used in the work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for the new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets.

C. Do not use "patched" forms for concrete surfaces exposed to view.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Structural cast-in-place concrete forming shall be paid for at the bid price in accordance with one of the following methods, unless indicated otherwise in the Bid Schedule.

B. All work specified herein shall be considered in each of the measurement and payment method(s) stipulated, unless indicated otherwise in the Bid Schedule.

4.02 STRUCTURAL CAST-IN-PLACE CONCRETE FORMING

A. Structural Cast-in-Place Concrete Forming, Inclusive. When no quantity is provided, structural cast-in-place concrete forming shall be considered inclusive to payment for work associated with cast-in-place concrete.

END OF SECTION

SECTION 03 15 00

CONCRETE ACCESSORIES

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. The work under this section shall cover furnishing and installing concrete accessories as shown on the contract drawings and specified herein.

1.02 RELATED WORK ELSEWHERE

A. Structural Cast-In-Place Concrete Forming - Division 03

B. Cast-in-Place Concrete - Division 03

1.03 APPLICABLE PROVISIONS (NONE)

1.04 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards:
    a. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete, Current Edition.
    b. ASTM C272 - Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions, Current Edition.
    c. ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete, Current Edition.
    d. ASTM C882 - Standard Test Method for Bond Strength for Epoxy-Resin Systems Used with Concrete by Slant Shear, Current Edition.
    e. ASTM D6 – Standard Test Method for Loss on Heating of Oil and Asphaltic Compounds, Current Edition.
    f. ASTM D297 – Standard Test Methods for Rubber Products - Chemical Analysis, Current Edition.
    g. ASTM D994 – Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type), Current Edition.
    h. ASTM D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types), Current Edition.
    i. ASTM D1752 – Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction, Current Edition.

2. Federal Specification TTS 227 and TTS 230, Current Edition.

1.05 SUBMITTALS

A. Contractor shall submit such product literature and catalog cuts of materials to be supplied to the rate these materials to the specifications. Information shall be in conformance with requirements of City submittals.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

PART 2 PRODUCTS AND MATERIALS

2.01 EXPANSION AND CONTRACTION JOINT FILLER

A. Preformed Bituminous. Bituminous expansion and contraction joint filler shall be preformed bituminous strips which complies with ASTM D994.

B. Removable Plastic Expansion Joint Cap: Snap-Cap by W.R. Meadows.

2.02 BOND BREAKER

A. Cast-in-Place Concrete Flatwork. Asphalt impregnated felts, 15 pound.

B. Cast-in-Place Concrete Formwork. Non-staining liquid product which imparts a waterproof film to prevent adhesion of concrete and will not leave a paint-impeding coating on the face of the concrete.

2.03 WATERPROOF SHEET MATERIAL FOR CURING

A. Provide one of the following, complying with ASTM C171: waterproof paper, polyethylene film or polyethylene-coated burlap.

B. Use only materials which are resistant to decay when tested in accordance with ASTM E154, as follows:
1. Polyethylene sheet not less than 6 mils thick; or
2. Water resistant barrier paper consisting of heavy papers laminated together with glass fiber reinforcement and overcoated with black polyethylene on each side.

2.04 CONCRETE REPAIR COMPOUND

A. Concrete repair compound shall be Sonopatch, Sonneborn Building Products; Embeco 411 Mortar, Master Builders, or equal.

2.05 PIPE SLEEVES AND ANCHOR BOLTS

A. Shall be furnished, installed, and anchored solid in their final location.

PART 3 CONSTRUCTION METHODS

3.01 INSTALLATION

A. Install accessories where shown on contract drawings and as specified herein.

B. Place bond breaker at junctures of slabs-on-grade with vertical walls.

C. Install expansion joint according to manufacturer's instructions; brace securely to prevent displacement.

D. Seal all exposed surfaces of expansion and contraction joints with joint sealer (3/4 inch deep and hold 1/8 inch below surface of concrete).

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Concrete accessories shall be paid for at the bid price in accordance with one of the following methods, unless indicated otherwise in the Bid Schedule.

B. All work specified herein shall be considered in each of the measurement and payment method(s) stipulated, unless indicated otherwise in the Bid Schedule.

4.02 CONCRETE ACCESSORIES

A. Concrete Accessories, Inclusive. When no quantity is provided, concrete accessories shall be considered inclusive to payment for work associated with cast-in-place concrete.

END OF SECTION

SECTION 03 20 00

CONCRETE REINFORCING

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. The work under this section shall cover furnishing and installing concrete reinforcing as shown on the contract drawings and as specified herein.

1.02 RELATED WORK ELSEWHERE

A. Concrete Accessories - Division 03

B. Cast-in-Place Concrete - Division 03

1.03 APPLICABLE PROVISIONS (NONE)

1.04 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. American Concrete Institute (ACI) Specifications and Standards:
   a. ACI 315 - Manual of Standard Practice for Detailing Reinforced Concrete Structures, Current Edition.
   b. ACI 318 - Building Code Requirements for Structural Concrete and Commentary, Current Edition.
2. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards:
   a. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement, Current Edition.
   b. ASTM A184 - Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement, Current Edition.
   c. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement, Current Edition.
   d. ASTM A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plan and Deformed, for Concrete, Current Edition.
3. American Association of State Highway Transportation Officials (AASHTO), Specifications and Standards:
   a. AASHTO M182 - Specification for Burlap Cloth Made from Jute or Kenaf, Current Edition
4. Concrete Reinforcing Steel Institute (CRSI) Specifications and Standards:
   a. CRSI - Manual of Standard Practice, Current Edition.

b. CRSI - Recommended Practice for Placing Reinforcing Bars, Current Edition.
c. CRSI - Recommended Practice for Placing Bar Supports, Specifications and Nomenclature, Current Edition.
d. CRSI - Recommended Practice for Reinforcing Bar Splices, Current Edition.

1.05 SUBMITTALS

A. Contractor shall submit such product literature and catalog cuts of materials to be supplied to relate these materials to the specification. Information shall be in conformance with requirements of City submittals.
1. Submit detailed reinforcing drawings prepared in accordance with ACI 315, including bar schedule with bar marks and bends indicated.
2. Comply with CRSI Manual of Standard Practice showing bar schedules, stirrup spacing, diagrams of bent bars and arrangements of concrete reinforcement. Include special reinforcement required at openings through concrete.
3. Verify dimensions and make proper allowance for fitting together work of other trades.

B. Submit a certification attesting that reinforcing steel meets the requirements of ASTM A615, including Supplementary Requirements S1, and that welded steel wire fabric meets the requirements of ASTM A185.
1. Submit certified copies of mill reports, tensile and bend tests for reinforcing steel on projects where the quantity of reinforcing exceeds 15 tons.
2. For information only, submit manufacturer's data and instruction for proprietary items, including reinforcement and accessories.

PART 2 PRODUCTS AND MATERIALS

2.01 REINFORCEMENT

A. Steel Bar Reinforcement. Main reinforcing and stirrups; ASTM A615, Grade 60.

B. Welded Wire Fabric. Welded wire fabric, flat sheets, ASTM A1064, 6x6-W2.9xW2.9, unless otherwise specified or indicated on the contract drawings.

C. Steel Tie Wire. Steel tie wire, ASTM A82, plain, cold-drawn, 16 gauge or heavier.

D. Supports For Reinforcement. Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcement in place complying with CRSI Manual of Standard Practice. For slabs on grade where base material will not support chairs, use supports with sand plates or horizontal runners to locate mesh properly in slab.

PART 3 CONSTRUCTION METHODS

3.01 FABRICATION

A. Fabricate and place to shapes and dimensions indicated or required to carry out intent of contract drawings and these specifications.

B. Bends for stirrups and ties shall be made around a pin having a diameter not less than four times the diameter of reinforcing bar. Bends for other bars shall be made around a pin having a diameter not less than six times diameter of bar, except that for bars larger than 1 inch, pin shall be not less than eight times diameter of bar.

1. Perform cutting and bending in the shop; bend and cut steel cold. Heating of reinforcement will not be permitted. Do not bend or straighten bars in a manner that will injure the material.
2. Field bending of bars shall not be allowed without the Engineer's approval.

C. Tagging shall be with metal, linen, or rope fiber tags filled in with machine or waterproof ink. Paper tags shall not be allowed.

D. Reinforcing bars shall conform accurately to the dimensions shown on the contract drawings.

3.02 PRODUCT DELIVERY, STORAGE AND HANDLING

A. For reinforcing steel fabricated on-site, shop from the mill in bundles, limited to one size and length, tagged with a waterproof tag showing the name of the mill, heat number, grade and size of the bars and identifying number.

B. For reinforcing steel fabricated off-site, deliver in bundles identified as to structure and shop drawing number. Identify each individual bar with a waterproof tag showing the grade, size and bar mark from the approved bar schedule.

C. Protect reinforcing steel and wire fabric from damage and from dirt, oil grease, other foreign matter, and rust-causing condition. Do not store reinforcement in direct contact with the ground.

3.03 CLEANING

A. Before placing and before pouring concrete, all reinforcement shall be thoroughly cleaned of all oil, dirt, loose mill scale, loose rust, or foreign matter that will destroy or reduce bond.

3.04 PLACING REINFORCEMENT

A. Placement. Metal reinforcement shall be accurately placed in accordance with approved Submittals and adequately secured in position by concrete or metal chairs

or spacers. Nails shall not be driven into forms to support reinforcement nor shall wire ties come in contact with forms.

B. Splicing. Lap at splices shall be sufficient to transfer stress between bars by bond and shear.
   1. Furnish reinforcing bars in full lengths as indicated on the contract drawings and approved Submittals.
   2. Do not splice bars unless indicated on the contract drawings or approved by the Engineer in writing. When authorized, make splices in accordance with ACI 318; perform welding in accordance with AWS D12.1.
   3. Splices generally shall be avoided at points of maximum stress. Minimum splice lap for stressed bars shall be forty times bar diameter.

C. Offsets in longitudinal bars at change of cross section shall be placed in region of lateral support. Slope of inclined portion of offset shall not be more than one in six and, in tied columns, ties shall be spaced not over 3 inches on centers for a distance of 1 foot below actual point of offset.

D. Embedded Items. The Contractor shall provide for the installation of all items embedded in the concrete, such as coil rod inserts, anchor bolts, dowels, etc., as shown on the contract drawings or as provided for in other Divisions of these specifications.
   1. All dowel bars shall be tied securely in place before pouring concrete.
   2. Provide for clearances with appurtenant materials and devices.

E. Drilled and Grouted or Epoxy Dowel Installation. Existing concrete which will be incorporated into new work and requiring integration with new concrete will be doweled as indicated on the contract drawings and as follows:
   1. Drill hole in existing concrete of size that is 3/4 inch larger in diameter than diameter of dowel bar. Incline the hole in the concrete such that the non-shrink grouting or epoxy will be retained in the hole.
   2. Fill hole with non-shrink grouting or epoxy.
   3. Immediately place dowel bar into hole.
   4. Allow grout or epoxy to take initial set before disturbing dowel bar.

F. Steel Reinforcing Fabric. Reinforce as detailed on the contract drawings; and where not indicated, reinforce with wire fabric, place 2 inches from the top of the slab.
   1. Flat sheets shall be used whenever available. Wire fabric shall lap 6 inches on side joints and 12 inches on end joints. Properly secure with annealed wire. Fabric shall be raised and secured in the correct location using permanent supports. Raising the fabric by hook during placement of concrete shall NOT be permitted.
   2. Alternately, in tight quarters and around appurtenances and openings, lap mesh reinforcement not less than one mesh space plus 2 inches, and tie.

G. Concrete Cover. The minimum cover of concrete for all reinforcement shall conform to the dimensions indicated on the contract drawings, which indicate the clear distance from the edge and end of the reinforcement to the face of the concrete surface. Provide clearance and spacing indicated on the contract drawings and approved Submittals, where so indicated.

1. Where no clearances are indicated, the thickness of the concrete cover over reinforcement shall be as follows:
    a. Concrete cast against and permanently exposed to earth - 3 inches;
    b. Formed concrete exposed to earth or weather - 2 inches;
    c. Formed concrete not exposed to earth or weather - 1-1/2 inches;
    d. Slabs not exposed to earth or weather - 1 inch.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Concrete reinforcing shall be paid for at the bid price in accordance with one of the following methods, unless indicated otherwise in the Bid Schedule.

B. All work specified herein shall be considered in each of the measurement and payment method(s) stipulated, unless indicated otherwise in the Bid Schedule.

4.02 CONCRETE REINFORCING

A. Concrete Reinforcing, Inclusive. When no quantity is provided, concrete reinforcing shall be considered inclusive to payment for work associated with cast-in-place concrete.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. The work covered under this section shall cover furnishing all materials, equipment and labor required to construct all cast-in-place concrete as shown on the contract drawings and as specified.

1.02 RELATED WORK ELSEWHERE

A. Structural Cast-in-Place Concrete Forming - Division 03

B. Concrete Accessories - Division 03

C. Concrete Reinforcing - Division 03

1.03 APPLICABLE PROVISIONS (NONE)

1.04 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. American Concrete Institute (ACI), Annual Book of ACI Standards:
    a. ACI 117/177R - Standard Specification for Tolerances for Concrete Construction and Materials and Commentary, Current Edition.
    b. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete, Current Edition.
    c. ACI 209.1R - Report on Factors Affecting Shrinkage and Creep of Hardened Concrete, Current Edition.
    d. ACI 301 - Specification for Structural Concrete, Current Edition.
    e. ACI 302.1R - Guide for Concrete Floor and Slab Construction, Current Edition.
    f. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete, Current Edition.
    g. ACI 305R - Hot Weather Concreting, Current Edition.
    h. ACI 306.1 (R2002) - Standard Specification for Cold Weather Concreting, Current Edition.
    i. ACI 308R - Guide to Curing Concrete, Current Edition.
    j. ACI 309R - Guide for Consolidation of Concrete, Current Edition.
    k. ACI 311.4R - Guide for Concrete Inspection, Current Edition.
    l. ACI 318/318R - Building Code Requirements for Structural Concrete and Commentary, Current Edition.

m. ACI 530/530.1/530R/530.1R - Building Code Requirements for Commentary for Masonry Structures and Specification for Masonry Structures and Related Commentaries, Current Edition.

n. ACI ASCC-1(05) - The Contractor's Guide to Quality Concrete Construction, Third Edition.

o. ACI CP-10/PACK - Craftsman Study Package for ACI Certification of Concrete Flatwork Technician/Finisher, Current Edition.

p. ACI MCP06 - ACI Manual of Concrete Practice, Parts 1 through 6, and Index, 2006 Edition.

q. ACI SCM-24 - Concrete Repair Basics, Current Edition.

r. ACI SP15 - Field Reference Manual: Standard Specifications for Structural Concrete ACI 301 with Selected ACI Reference, Current Edition.

s. ACI SP-71 - ASTM Standards in ACI 318, Current Edition.

2. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards:

a. ASTM C33 - Standard Specification for Concrete Aggregates, Current Edition.

b. ASTM C70 - Standard Test Method for Surface Moisture in Fine Aggregate, Current Edition.

c. ASTM C94 - Standard Specification for Ready-Mixed Concrete, Current Edition.

d. ASTM C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2-inch or [50 mm] Cube Specimens), Current Edition.

e. ASTM C125 - Standard Terminology Relating to Concrete and Concrete Aggregates, Current Edition.

f. ASTM C127 - Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate, Current Edition.

g. ASTM C128 - Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Fine Aggregate, Current Edition.

h. ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine, Current Edition.

i. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete, Current Edition.

j. ASTM C150 - Standard Specification for Portland Cement, Current Edition.

k. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete, Current Edition.

l. ASTM C191 - Standard Test Methods for Time Setting of Hydraulic Cement by Vicat Needle, Current Edition.

m. ASTM C219 - Standard Terminology Relating to Hydraulic Cement, Current Edition.

n. ASTM C226 - Standard Specification for Air-Entraining Additions for Use in the Manufacture of Air-Entraining Hydraulic Cement, Current Edition.
o. ASTM C233 - Standard Test Method for Air-Entraining Admixtures in Concrete, Current Edition.
p. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete, Current Edition.
q. ASTM C311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for use as a Mineral Admixture in Portland-Cement Concrete, Current Edition.
r. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete, Current Edition.
s. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete, Current Edition.
t. ASTM C535 - Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine, Current Edition.
u. ASTM C566 - Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying, Current Edition.
v. ASTM C595 - Standard Specification for Blended Hydraulic Cement, Current Edition.
w. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzlan for Use in Concrete, Current Edition.
x. ASTM C688 - Standard Specification for Functional Additions for Use in Hydraulic Cements, Current Edition.
y. ASTM C989 - Standard Specification for Slag Cement for Use in Cement and Mortars, current edition.

3. Portland Cement Association (PCA) Standards and Specifications:
   a. PCA - Design and Control of Concrete Mixtures, Current Edition.

1.05 SUBMITTALS

A. Submit such product literature and catalog cuts of materials to be supplied to relate these materials to the specification. Information shall be in conformance with requirements of City submittals.

B. <u>Concrete Design Mix</u>

1. Prior to the start of placing of concrete, submit the design mix for each class of concrete, indicating that the concrete constituents and proportions will result in a concrete mix meeting the physical requirements for each class of concrete specified. Submit with the design mix, laboratory test reports and manufacturer's certificates attesting the conformance of constituents with these specifications.
2. Do not vary the proportions of the constituents or source of material of the approved mix without submitting corresponding test result documentation to the Engineer for review and approval.

3. Design mix shall indicate proportions of cement, aggregate and water, and names and proportions of admixtures and air-entraining agents.
4. Provide certification that the design mix complies with all ACI and ASTM requirements.

PART 2 PRODUCTS AND MATERIALS

2.01 CEMENT

A. Cement shall be Portland Cement ASTM C150 Type I or IA, except as otherwise noted or approved. Type III cement shall only be used for Class L concrete, or when approved by the Engineer.

B. A singular brand and manufacturer of cement shall be used for the entire work.

2.02 FLY ASH

A. Fly ash shall conform to ASTM C618 Class C.

B. A singular source of fly ash shall be used for the entire work.

2.03 SLAG

A. Slag shall be ground granulated blast furnace slag conforming to ASTM C989.

2.04 AGGREGATE

A. Aggregate shall consist of clean, hard durable sand, gravel, crushed gravel or crushed rock.

B. Aggregate shall conform to the requirements of ASTM C33. Fine and coarse aggregate shall meet ASTM C33 grading requirements. Coarse aggregates shall be graded in accordance with ASTM gradations as follows:
1. 3/4 inch maximum coarse aggregate - ASTM No. 67
2. 1-1/2 inch maximum coarse aggregate - ASTM No. 4

C. Maximum aggregate size shall be as defined in the Concrete Schedule, or where not defined in the Concrete Schedule, as defined by dimensional constraints for cast-in-place concrete as follows.
1. Not larger than one-fifth of the narrowest dimension between sides of the forms;
2. Not larger than one-third the thickness of the slab;
3. Not larger than three-fourths of the minimum clear spacing between individual reinforcing bars or wire, bundles of bars, or prestressing tendons or ducts.

2.05 MIXING WATER

A. Mixing water shall be natural or treated water, clean and free from injurious amount of oil, acid, alkali, chlorides and sulfates, other common salts, organic matter or other deleterious substances.

B. Mixing water shall yield cement paste complying with the requirements ASTM C109 and ASTM C191.

2.06 ADMIXTURES

A. All admixtures are subject to the written approval of the Engineer and shall be used in strict accordance with the manufacturer's recommendations.

1. Air-Entraining Admixture
    a. All concrete exposed to weather and freeze-thaw cycles shall be air-entrained, unless otherwise specified.
    b. Air-Entraining admixture shall conform to ASTM C260.
    c. Air-Entrainment shall be as indicated for each class as in the Concrete Schedule.
2. Water-Reducing, Set-Controlling Admixtures
    a. Water-Reducing, Set-Controlling admixtures shall conform to ASTM C494, Type A for water-reducing, Type C for accelerating, Type D for water-reducing and retarding, and Type E for water-reducing and accelerating.

B. Admixtures containing calcium chloride or soluble chloride shall not be used.

2.07 CURING COMPOUND - EXTERIOR

A. Curing compound shall comply with ASTM C309, Type 2; resin, white pigmented.

PART 3 CONSTRUCTION METHODS

3.01 COORDINATION

A. Examine the drawings and specifications for work of other sections or other contractors and coordinate such work with the requirements of this Section; make provisions for installation of such items as sleeves, pipes, conduits, inserts and hangers in a manner that will not impair or weaken concrete construction.

3.02 READI-MIX CONCRETE

A. Acceptability and Use. Readi-mix concrete shall be designed on the basis of strength, durability, impermeability, and exposure condition, as required for the intended use of the structure by methods specified in ACI 211.1 and ACI 318. All readi-mix concrete shall comply with the water-cement ratio for each specific class of concrete as specified in the Concrete Schedule. Concrete design mix, complete

with sample test results shall be submitted to the Engineer for approval prior to placing any concrete.

1. Failure to Meet Strength Requirements. Failure to meet strength requirements shall be as defined in Concrete Quality Control.
2. Watertight Concrete. All concrete exposed to earth or water shall be watertight, shall have a water-cement ratio as specified, and shall be air-entrained as specified in the Concrete Schedule.
    a. Construct keyways as indicated on the contract drawings.

B. Mix Proportioning. Mix proportioning shall be the responsibility of the Contractor and shall be submitted for review and approval by the Engineer, in accordance with these specifications.

1. Select proportions for concrete to obtain the quality requirements for the class of concrete as specified in the Concrete Schedule. Contractor, at their expense, shall have an approved independent laboratory prepare design mixes for each specified concrete class.
2. Slump. Slump for class of concrete shall be as specified in the Concrete Schedule. The Contractor shall at their expense, make field slump tests in accordance with ASTM C143 and Concrete Quality Control.
3. Adjustment to Concrete Mixes. Design mix adjustments may be requested by the Contractor when characteristics of materials, conditions, weather, test results, or other circumstances warrant. Laboratory test data for revised design mixes and strength results shall be submitted and approved before using in the work. No change in contract price will be allowed for these changes.
4. Addition of Water to the Batch. Addition of water to the batch delivered to the site shall be in strict accordance with ASTM C94. This shall be the Contractor's responsibility and by their direction, following consultation with the Engineer.
    a. Addition of water to the batch shall be one time only. Total gallons of water added to the batch shall be recorded on the load ticket, which shall be supplied to the Engineer prior to that delivery truck leaving the site. If water is permitted to be added to mixed concrete upon arrival at the job, an additional mixing of 30 revolutions of the drum shall be required.
    b. Contractor shall adjust the water-cement ratio of the batch to the corresponding value based on the addition of water to the batch and shall submit this information to the Engineer with adjusted strength data for the final batch proportion.
    c. At no time shall the addition of water cause the water-cement ratio specified in the concrete class schedule to be exceeded.

3.03 GENERAL

A. Unless otherwise specified, conform to ACI 304, 305, and 306 for concrete installation requirements such as preparation, mixing, conveying, depositing, curing,

and cold and hot weather requirements; consolidate concrete in accordance with ACI 309.

B. Concrete not placed within 90 minutes or 300 revolutions, whichever occurs first, after the first mixing of the cement and aggregates will be rejected.

C. Contractor shall indicate on record set of Drawings at site, for review prior to installation, a pouring program for concrete work showing unit of operation, method of pouring, installation of construction/control joints, expansion joints and all necessary work.

D. Proper grade marker or stakes shall be used by Contractor to establish grades for ramps, platforms, sidewalks, slopes to drains, inlets, etc.

E. Trenches, forms, conveying equipment shall be prepared to receive concrete in accordance with ACI 304.

F. Place concrete footings upon undistributed clean surfaces, free from frost, ice, mud and water; when foundation is on dry soil or pervious material, lay waterproof sheathing paper over earth surfaces to receive concrete.

G. Rock surfaces upon which concrete is to be placed, make level, clean, free from all objectionable coatings, water, mud, debris, loose semi-detached or unsound fragments; level surfaces to receive sand cushion placed to minimum thickness of 2 inches.

H. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperature and mechanical injury; maintain with minimum moisture loss and relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete.

I. All freshly cast concrete shall be protected from damaging effects of the elements freezing, rapid drop in temperature and loss of moisture and from future construction operations.

3.04 PREPARATION OF EQUIPMENT AND PLACE OF DEPOSIT

A. Before placement, clean equipment for mixing and transporting the concrete; remove debris and ice from all surfaces upon which concrete is placed; clean reinforcement of dirt, loose rust, and mill scale, or other coatings.

B. Remove water from all areas before depositing concrete; before depositing new concrete on or against concrete that has set, thoroughly roughen; clean existing surfaces of laitance, foreign matter or loose particles; retighten forms; slush existing surfaces with neat cement grout coat; place new concrete before grout has attained initial set; give horizontal construction joints grout brush coat of cement, fine aggregate, in same proportions as concrete to be placed.

C. Thoroughly wet the stone base on which slabs are to be placed where no vapor barrier is indicated.

D. Check compaction of fill and proper grade for slabs-on-grade. Check screeds and exercise care to prevent disturbing screeds during placement. Provide for construction joints in slabs-on-grade at 20 feet maximum in each direction unless shown otherwise on the contract drawings. Place expansion joint material at junctures of slabs-on-grade with vertical walls and as otherwise shown.

E. Remove debris, excess form oil, and water from formwork; avoid washing newly deposited concrete.

3.05 MIXING

A. Ready-mixed concrete shall be mixed and delivered in accordance with ASTM C94 and ACI 304. The production facilities shall comply with the requirements of the National Ready Mixed Concrete Association Certification Plan as regards materials storage and handling, batching equipment, central mixer, truck mixers, agitators, non-agitating units, ticketing system, etc.

B. Do not over-mix; do not use concrete which is retained in mixers so long as to require additional water in excess of design mix water to permit satisfactory placing; retempering of mix is not permitted.

C. Concrete shall be delivered to the site of the work and the mixed concrete discharged completely within 1-1/2 hours after water has been added to cement. In hot weather, or under conditions contributing to quick stiffening of concrete, this time may be reduced by the Engineer.

D. Concrete delivered shall arrive at the site having a temperature not less than 50 Degrees F nor greater than 85 Degrees F, unless otherwise permitted by the Engineer.

3.06 CONVEYING

A. Convey concrete from the mixer to the final deposit by methods that will prevent segregation or loss of materials.

B. Use of aluminum conveyances is not permitted.

3.07 CONCRETE PLACEMENT

A. Place concrete, including drops greater than 60 inches using recommended practices in accordance with ACI 304 and ACI 318. Once pouring operation commences, it shall be carried out as a continuous operation until a section is completed.

B. Deposit concrete as nearly as practical in its final position to avoid segregation due to rehandling or flowing; do not use vibrators to move concrete horizontally within the forms.

C. Do not use retempered concrete or concrete contaminated by foreign material.

D. Plan and conduct concrete placement to insure that the concrete is kept plastic and that the concrete is free of cold joints.

E. Where there is a time delay greater than 45-minutes between adjacent concrete placement, a bulkhead construction joint, complete with waterstops where required, must be installed.

F. Do not commence placing when the sun, heat, wind or limitations of facilities provided prevent proper finishing or curing.

G. Discontinue concreting when the descending natural air temperature falls lower than 40 Degrees Fahrenheit unless preparations are made and in place to heat or insulate concrete in accordance with the cold weather concreting requirements of this specification.

H. Concrete for walls shall be deposited in approximately horizontal layers not to exceed 24 inches in height to avoid segregation due to rehandling and flowing.

I. Concrete shall not be placed or poured in water. Water level shall be removed or lowered in a manner approved by Engineer. Excess water shall not be permitted. Powdering a mixture of cement to absorb excess water shall not be permitted.

J. Concrete shall be placed before initial set has occurred. Placing should be carried on in such manner that the concrete in the form is still plastic and can be integrated with fresh concrete.

K. Contractor shall notify Engineer of concrete pouring schedule one day in advance of pour to allow for inspection of reinforcing and forms.

L. Bottom dump buckets may be used for transporting mixed concrete to the desired location. Particular care shall be taken to avoid jarring or bumping as this may cause segregation.

M. Where chutes are used to transport concrete, they shall be of metal or wood with metal lining and should have a slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal so that the concrete will travel fast enough to keep the chute clean but slow enough to avoid segregation of materials. The end of each chute shall be provided with a baffle to help prevent segregation, or the concrete should be discharged through a tremie or elephant trunk directly into the form.

N. Elephant trunks and/or tremies shall be used in walls and columns to prevent free fall of the concrete and to allow the concrete to be placed through the cage of reinforcing steel.

O. Pumping equipment shall be of suitable type, without Y-sections, and with adequate pumping capacity. Loss of slump in pumping shall not exceed 1-1/2 inches.

3.08 CONSOLIDATION

A. Each concrete layer placed shall be compacted by mechanical internal vibrating equipment supplemented by hand spading, rodding, or tamping.

B. The period of concrete vibration shall not be less than two seconds nor more than five seconds at any one point.

C. Consolidate concrete thoroughly as it is placed in order to secure a dense mass; work concrete well around the reinforcement and embedded items and into the corners of the forms.

D. Use internal vibrators inserted vertically over the entire area of the placement; form vibrators not permitted; internal vibrators shall maintain a minimum of 5000 impulses when submerged in concrete.

E. Vibrate until voids are eliminated, coarse aggregate is suspended in mortar, and entrapped air bubbles begin to rise to the surface; concrete should move back into the space vacated by the vibrator; vibration duration shall be limited only to the time necessary to produce consolidation without causing segregation.

F. Space vibrator insertions such that the area visibly affected by the vibrator overlaps the adjacent just-vibrated area by a few inches.

G. Penetrate at least 6 inches into previously placed layers in order to bond between layers and avoid cold joints.

H. Take care not to over-vibrate air entrained concrete; place vibrator to eliminate honeycombing but avoid excess vibrating that bleeds all entrapped air from the mix.

I. Do not use vibrators to transport concrete.

3.09 JOINTS AND KEYWAYS

A. Construct expansion, control, and isolation joints and keyways only where indicated on the drawings or at additional locations approved by the Engineer (and as shown on the Standard Details).

B. Where the placing of concrete is discontinued, clean off laitance and other objectionable material to a sufficient depth to expose sound concrete as soon as

concrete is firm enough to retain its form; smooth the top surface of concrete adjacent to the forms with a trowel to minimize visible joints on exposed faces.

C. Immediately upon completion of the work of placing concrete, remove accumulations splashed upon the reinforcement and the surfaces of the forms; perform this removal before concrete takes its initial set; clean reinforcing steel carefully to prevent damage to the concrete steel bond.

D. Do not halt work within 18 inches of the top of any face.

E. For bonded horizontal joint construction, roughen the surface and expose the aggregate; clean the surface thoroughly by wet sandblasting, by cutting with high-pressure water jet or by other approved methods; perform cleaning after the concrete has hardened to prevent raveling of the surface below the desired depth.

F. Before bonding concrete is placed, clean the surface of loose or soft particles or other objectionable materials and keep wet for a minimum period of 12 hours.

G. Cover the cleaned and saturated surface with a coating of neat cement grout and deposit new concrete before the grout has attained its initial set.

3.10 CURING

A. Concrete shall be wet cured by immersion of moisture-retaining covers in conformance with ACI 308 or shall receive curing compound in accordance with ACI 309.

B. Water curing is the preferred method of protection for curing concrete other than under hot weather conditions; cover exposed surfaces with a saturated material (burlap or cotton mats) and keep wet continuously with a soil soaker hose for 7 curing days for all concrete except high early strength concrete; leave covering in place, without wetting, for an additional 3 days.

C. A curing day is defined as 24-hour day when the concrete surfaces are kept moist and the uniform temperature of the concrete mass is between 55 Degrees Fahrenheit and 75 Degrees Fahrenheit.

D. Curing shall start as soon as free surface water disappears after finishing. Where forms are not removed immediately, curing shall be accomplished in a manner acceptable to the Engineer.

E. Curing compounds may not be used on surfaces that are to receive additional concrete, paint or tile.

F. Curing and sealing compound shall not be applied to steel reinforcing anchors, water stops, construction joints, or surfaces to be bonded to other concrete.

G. When using a curing compound, keep surfaces moist after the forms are removed, and the form tie holes repaired; after the surfaces are finished, apply the curing compound according to the manufacturer's recommendations; remove forms only as required to advance repair of tie holes and minor defects.

H. Slabs: Immediately following slab finishing, apply liquid membrane-forming curing compound or begin water curing before the surface becomes dry.

I. Vertical Surfaces: When the forms are removed entirely, spray the surface with water and allow it to reach a uniformly damp appearance with no free water on the surface; apply curing compound or begin water curing.

J. For curing concrete under hot weather conditions, see Hot Weather Requirements in this section.

K. For curing concrete under cold weather conditions, see Cold Weather Requirements in this section.

3.11 CONCRETE WALL FINISHES

A. Complete screeding and darbying of top of walls before excess moisture or bleeding water is present on the surface.

B. Do not begin subsequent finishing operations until surface water has disappeared.

C. Refer to Concrete Schedule, included in this specification section, for finish type at each location, defined as follows:

1. Rough Form Finish: (Type W1)
   a. No form facing materials specified.
   b. Patch tie holes and defects.
   c. Chip off fins 1/4 inch or more in height.
2. Smooth Form Finish: (Type W2)
   a. Use a form facing material that will produce a smooth, hard, uniform texture on the concrete.
   b. Keep seams to a practical minimum.
   c. Patch tie holes and defects.
   d. Remove all fins.
3. Smooth Rubbed Finish: (Type W3)
   a. Produce a Smooth Form Finish.
   b. Wet surface and rub with a Carborundum brick until uniform color and texture are produced.
   c. Perform rubbing no later than 24 hours after forms are removed.
   d. Do not use any cement grout other than the paste drawn from the concrete itself by rubbing.
   e. Thoroughly wash the surface with water.
4. Smooth Troweled Finish: (Type W4)
   a. Produce a Smooth Rubbed Finish.
   b. After wet-rubbing, finish with a steel trowel to increase compaction of fines and to provide maximum density.

5. Smooth Finish (Grout Cleaned): (Type W5)
    a. Use for architectural surfaces exposed to general view, unless other indicated.
    b. Mix 1 part portland cement and 1-1/2 parts fine sand with sufficient water to produce grout having consistency of thick paint; use white portland cement in combination with normal portland cement to achieve uniform surface color after drying.
    c. Wet surface of concrete and uniformly apply grout with brush or spray gun completely filling air bubbles; surface with a wood float scouring wall vigorously.
    d. Allow grout to partially set for one to two hours, depending on weather conditions; in hot dry weather, keep damp, using fine fog spray.
    e. When grout has hardened sufficiently to be scraped from wall with edge of steel trowel without removing grout from small air holes, cut off all grout that can be removed with trowel.
    f. Allow surface to dry thoroughly then rub vigorously with dry burlap to completely remove dried grout; there shall be no visible film or grout remaining after this rubbing.
    g. The entire cleaning operation for any area must be completed the day it is started; no grout shall be left on overnight, and sufficient time shall be allowed for grout to dry after it has been cut with trowel so it can be wiped off clean with burlap.
    h. After entire surface has been grout cleaned, wipe off any slightly dark spots or streaks with fine abrasive hone.

3.12 CONCRETE SLAB FINISHING

A. Complete screeding and darbying slabs before excess moisture or bleeding water is present on the surface.

B. Do not begin subsequent finishing operations until surface water has disappeared and the concrete will sustain foot pressure with only approximately 1/4 inch indentation.

C. Refer to Concrete Schedule, included in this specification section, for finish type at each location, defined as follows:
    1. Smooth Float Finish: (Type S1)
        a. Consolidate concrete with a power-driven disc-type float or a combination floating-troweling machine with metal float shoes attached.
        b. Machines which have a water attachment for wetting the concrete during the finishing operation are prohibited.
        c. Check and level surface plane to a tolerance not exceeding 1/4 inch in 10 feet when tested with a 10-foot straightedge. Cut down high spots and fill low spots; immediately after re-leveling, refloat surface to a uniform, smooth, granular texture.

d. Where slab drainage is indicated, take care to maintain accurate slopes for drainage.

2. Steel Troweled Finish: (Type S2)
   a. Produce a Smooth Float Finish.
   b. After float finishing, steel trowel surface as specified in Concrete Schedule to increase the compaction of fines and to provide maximum density and wear resistance.
   c. Steel Troweled Finish: Screed and bull float or darby. Give preliminary float finish, true, even and free from depressions; float surface with hand or machine floats; compact surface with not less than 2 thorough and complete steel troweling operations.
   d. Tolerance on finished steel troweled floors in no instance shall exceed 1/8 inch in 10'-0" on surface; where floor drains occur, slope floors to drains.
   e. Buffing: After concrete floors have been properly cured, buff thoroughly to remove soluble salt incrustation or other foreign substances.
3. Broom Finish: (Type S4)
   a. Draw stiff broom over previous Smooth Float Finish, to obtain non-slip finish.

3.13 CONCRETE SIDEWALKS

A. Concrete sidewalk construction shall be as specified in City specifications.

3.14 CONCRETE CURB AND GUTTER

A. Concrete curb and gutter construction shall be as specified in City specifications.

3.15 HOT WEATHER REQUIREMENTS

A. Comply with ACI 305R unless otherwise specified herein below.

B. Hot weather conditions are deemed to exist when the temperature in the forms is 75 Degrees Fahrenheit or above, or a combination of high air temperature, low relative humidity and wind velocity impair the quality of fresh or hardened concrete; take protective measures for mixing, transporting and placing concrete in accordance with ACI 305R.

C. The temperature of the concrete at the place of discharge may not exceed 85 Degrees Fahrenheit.
   1. If ice is used to lower temperature, place crushed, shaved or chipped ice directly into the mixer as part or all of the mixing water; mix until ice is completely melted.
   2. Record the concrete temperature at the time of discharge.

D. Do not add water that will cause the proportions to exceed the maximum water-cement ratio shown in Table I.
   1. Notify the Engineer before adding any water to the concrete mix.
   2. Record the amount of water added to the concrete at the jobsite.

E. Discharge concrete within 45 minutes or 100 revolutions, whichever occurs first, after the first mixing of cement and aggregates.

F. Placing and Curing:
   1. Place concrete promptly upon arrival.
   2. Provide at least one standby vibrator for each 3 vibrators in use.
   3. Protect concrete from direct sunlight; keep forms covered and moist by means of water sprinkling or the application of continuously wetted burlap or cotton mats for a minimum of 24 hours. Windbreaks and/or sunshades shall be provided as directed by the Engineer.
   4. When forms are removed, provide wet cover to the newly exposed surfaces to avoid exposure to hot sun and wind.
   5. Continue specified water curing methods for 10 days; leave covering in place 4 additional days; do not permit alternate wetting and drying cycles.
   6. For slabs on grade, beam and deck concrete, and other horizontal placements protect the surface between finishing operations using one or more of the following methods:
      a. Careful use of a fog nozzle.
      b. Spreading and removing polyethylene sheeting between finishing operations.
      c. Application of mono-molecular film after the strike-off.

G. During extremes in weather, floor slabs shall not be cast unless the slab is protected by a roof and other suitable protective measures are provided. After curing has been completed, the floor shall be exposed to the air for 48 hours prior to allowing traffic on the floors.

3.16 COLD WEATHER REQUIREMENTS

A. Comply with ACI 306.1 (R2002) unless otherwise specified herein below.

B. Cold weather is defined any time when the daily temperature is 40 Degrees Fahrenheit or lower during placement and the protection period. If at any time during the progress of the work, the temperature drops below 40 Degrees F., the Contractor shall make suitable provisions to protect the concrete by use of insulation materials such as blankets, mats, etc., and equipment for providing artificial heat.

C. Combustion type temporary heating devices shall be vented outside of any temporary enclosure and building envelope. Combustion gases shall not be allowed in any temporary enclosure and building envelope.

D. Protect concrete surfaces from freezing for at least 24 hours after placement.

E. All surfaces in contact with newly-placed concrete including formwork, reinforcement and subgrade must be above 35 Degrees Fahrenheit.

F. Use preparation methods capable of producing concrete with a temperature not more than 85 Degrees Fahrenheit, and not less than 55 Degrees Fahrenheit, at the time of placement.

G. Do not heat concrete ingredients to a temperature higher than that necessary to keep the temperature of the mixed concrete, as placed, within the specified temperatures. (Do not heat water in excess of 140 Degrees Fahrenheit.)

H. Concrete shall have a temperature of not less than 55 Degrees Fahrenheit when placed; mix concrete at a temperature between:

1. 60 Degrees Fahrenheit and 70 Degrees Fahrenheit when outside air temperature is above 30 Degrees Fahrenheit.
2. 65 Degrees Fahrenheit and 75 Degrees Fahrenheit when outside air temperature is between 0 Degrees Fahrenheit and 30 Degrees Fahrenheit.
3. 70 Degrees Fahrenheit and 80 Degrees Fahrenheit when outside air temperature is below 0 Degrees Fahrenheit.

I. Follow concrete placement with tarpaulins or other readily movable coverings, so only a few feet of concrete is exposed to the outside air at any time.

J. Maintain the temperature and moisture conditions specified in all parts of the newly placed concrete by covering, insulating, housing or heating; arrange for protection methods in advance of placement.

K. Maintain concrete at a temperature of not less than 55 Degrees Fahrenheit nor more than 70 Degrees Fahrenheit for a period of 3 days after placement.

L. A thermometer accurate to plus or minus 2 Degrees F shall be placed under the curing blanket. Additional insulation shall be supplied as required to maintain the temperature above 55 Degrees F.

M. After the curing period, the temperature of the exposed surface shall not be permitted to drop faster than 30 Degrees F in 24 hours.

N. Do not remove forms during the initial protection period.

O. Protect insulation against wetting that will impair its insulating value using moisture-proof cover material; keep insulation in close contact with concrete.

P. Construct enclosure to withstand wind and snow loads and be reasonably airtight; provide sufficient space between the concrete and enclosure to permit free circulation of heated air.

Q. Use vented heaters; do not permit heaters to heat or dry concrete locally. Unvented salamanders or other heaters which produce carbon dioxide as by-products shall not

be permitted within enclosures or inside buildings. If heaters are used, precautions shall be taken to prevent drying of the slab through the use of water jackets or other suitable methods.

R. Maintain relative humidity above 40% within heated enclosures before construction supports are removed.

S. Monitor temperature to insure concrete is kept within specified limits recording time and concrete temperature every 8 hours.

T. Assure concrete has developed necessary strength before removing forms; provide additional test cylinders with the same protection as the structure they represent to verify concrete strength before construction supports are removed.

U. If water curing is used, terminate at least 12-hours before end of temperature protection period. Permit concrete to dry.

V. After the required protection period gradually reduce the concrete temperature within an enclosure or insulation at a rate not to exceed 20 Degrees Fahrenheit per day until the outside temperature has been reached.

W. Apply membrane forming curing compound to concrete surfaces during the first period of above-freezing temperatures after forms are stripped and before air temperature rises to 50 Degrees Fahrenheit; apply membrane forming curing compound to slabs as soon as finishing operations are completed, except where live steam curing is used.

3.17 DELIVERY TICKETS

A. With each load of concrete delivered to the job there shall be furnished by the ready-mixed concrete producer duplicate delivery tickets, one for the Contractor and one for the Engineer. Delivery tickets shall provide the following information:

1. Date and serial number of ticket;
2. Name of ready-mixed concrete plant;
3. Job location;
4. Contractor;
5. Type and brand name of cement;
6. Mix number or specified cement content in bags per cubic yard of concrete;
7. Truck number;
8. Time dispatched stamped by a time clock;
9. Amount of concrete in load in cubic yards;
10. Admixtures in concrete, if any;
11. Maximum size of aggregate;
12. Water added at job, if any;
13. Slump of concrete ordered

TABLE 1
CONCRETE CLASS SCHEDULE

Parameter Value	Compressive Strength (PSI) 28-Day	Water-Cement Ratio Maximum	Air Content Range (%) Minimum-Maximum	Slump Range (Inches) Minimum-Maximum	Coarse Aggregate (Inches) Maximum
Class A	4,000	0.5	1 to 2	2 to 4	3/4
Class B	4,000	0.5	1 to 2	2 to 4	1-1/2
Class C	4,000	0.5	5 to 7	2 to 4	3/4
Class D	4,000	0.5	4 to 6	2 to 4	1-1/2
Class E (Interior)	3,000	0.5	1 to 2	2 to 4	3/4
Class F (Exterior)	3,000	0.5	5 to 7	2 to 4	1-1/2
Class G	2,000	0.67	1 to 2	4 to 6	1-1/2
Class H	5,000	0.45	1 to 2	2 to 4	3/4
Class I	5,000	0.45	1 to 2	2 to 4	1-1/2
Class J	5,000	0.45	5 to 7	2 to 4	3/4
Class K (Exterior)	5,000	0.45	4 to 6	2 to 4	1-1/2
Class L	3,000 psi @24 hours	0.40	5 to 7 4 to 6	2 to 4 2 to 4	3/4 1-1/2

TABLE 2
CONCRETE SCHEDULE
USES AND PROPERTIES

Use	Finish	Class and Considerations
Structural (not including water-retaining structures)		
Exposed foundations and walls	S2 Top, W5 Sides	Class C
	S2 Top, W5 Sides	Class D
Buried walls and footing walls, (Exterior)	W1	Class C
	W1	Class D
Slabs	S4	Class C
(Exterior)	S4	Class D
Equipment pads and bases	S4 Top, W5 Sides	Class F (Exterior)
Curbing, sidewalk, endwalls,	S4 Top, W5 Sides	Class C
driveways and ramps	S4 Top, W5 Sides	Class D
Manhole bases and benches	Special Construction	Class E
Pavement base, cradles	Special Construction	Class E
and inlet walls		Class F
Mass and fill	None	Class G
Traffic areas requiring		
early access or use	Special Construction	Class L

END OF SECTION

SECTION 03 62 00

NON-SHRINK GROUTING

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. The work under this section shall cover furnishing and installing a non-shrink fluid precision grout material, forming, placing and curing where shown on the contract drawings or required by equipment manufacturers, equipment bases shall be grouted in position.

1.02 RELATED WORK ELSEWHERE

1.03 APPLICABLE PROVISIONS (NONE)

1.04 APPLICABLE PUBLICATIONS (NONE)

1.05 SUBMITTALS

A. Contractor shall submit such product literature and catalog cuts of materials to be supplied to relate these materials to the specification. Information shall be in conformance with requirements of City submittals.

PART 2 PRODUCTS AND MATERIALS

2.01 NON-SHRINK GROUTING

A. Non-shrink grouting shall be as manufactured by Master Builders, U.S. Grout Corporation, or equal.

PART 3 CONSTRUCTION METHODS

3.01 PREPARATION AND INSTALLATION

A. Concrete foundation shall be rough and relatively level. Contractor shall remove laitance down to sound concrete and prepare concrete in accordance with manufactured recommendations.

B. Preparation of grout shall be in paddle type mortar mixer or other suitable mechanical mixer.

C. Placing of grout shall be at temperatures of 45 Degrees Fahrenheit to 75 Degrees Fahrenheit. Temperature shall be maintained above 40 Degrees Fahrenheit until strength exceeds 4000 psi.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Non-shrink grouting shall be paid for at the bid price in accordance with one of the following methods, unless indicated otherwise in the Bid Schedule.

B. All work specified herein shall be considered in each of the measurement and payment method(s) stipulated, unless indicated otherwise in the Bid Schedule.

4.02 NON-SHRINK GROUTING

A. Non-Shrink Grouting, Inclusive. When no quantity is provided, non-shrink grouting shall be considered inclusive to payment for work associated with the related equipment.

END OF SECTION

SECTION 05 05 23

METAL FASTENINGS

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. The work under this section shall cover furnishing and installing metal fastenings as shown on the contract drawings and as required by equipment manufacturers.

1.02 RELATED WORK ELSEWHERE

A. Cast-in-Place Concrete - Division 03

B. Metal Fabrications - Division 05

C. Handrails and Railings - Division 05

1.03 APPLICABLE PROVISIONS (NONE)

1.04 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, Current Edition.
   a. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
   c. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

PART 2 PRODUCTS AND MATERIALS

2.01 METAL FASTENINGS

A. Stainless Steel. Metal fastenings shall be B8T, Stabilized 18 Chromium 8 Nickel conforming to the requirements of ASTM A193, furnished with brass nuts.

B. Zinc Plated Steel. Metal fastenings shall be S.A.E. Grade 5.

C. High-Strength. Metal fastenings shall be ASTM A325.

D. Standard Metal Fastenings shall be ASTM A307.

PART 3 CONSTRUCTION METHODS

3.01 METAL FASTENINGS

A. Stainless steel, high strength, and standard metal fastenings shall be used where shown on contract drawings.

B. Metal fastenings furnished by equipment manufacturers shall be installed in accordance with manufacturer recommendations.

C. Zinc plated steel Metal Fastenings shall be installed in all other locations.

PART 4 MEASUREMENT AND PAYMENT

4.01 METAL FASTENINGS

A. General. Metal fastenings shall be paid for at the bid price in accordance with one of the following methods, unless indicated otherwise in the Bid Schedule.

1. Metal Fastenings, Inclusive. When no quantity is provided, metal fastenings shall be considered inclusive to payment for work associated with the related equipment or construction.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. The work under this section shall cover furnishing and installing the ~~fabricated metal~~hot-dip galvanized guardrails as described in this section and as shown on the contract drawings.

1.02 RELATED WORK ELSEWHERE

A. Metal Fastenings - Division 05

B. Handrails and Railings - Division 05

1.03 APPLICABLE PROVISIONS (NONE)

1.04 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. ~~The Aluminum Association (AA~~American Institute of Steel Construction (AISC), Specifications and Standards:
   a. ~~AA Sections 6~~AISC Section 1.23 - Specification for the Design, Fabrication and ~~7 - Aluminum~~Erection of Structural Steel for Buildings (Riveted, Bolted and Arc-Welded Construction~~ Manual, Specifications for Aluminum Structures,),~~ Current ~~Edition~~Editions.
2. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, Current Editions.
   a. ASTM ~~B209~~A36 - Standard Specification for ~~Aluminum and Aluminum-Alloy Sheet and Plate~~Carbon Structural Steel, Current Edition.
   b. ASTM ~~B210~~A123 - Standard Specification for ~~Aluminum and Aluminum-Alloy Drawn Seamless Tubes~~Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products, Current Edition.
   c. ASTM ~~B211~~A153 - Standard Specification for ~~Aluminum and Aluminum-Alloy Bar, Rod, and Wire~~Zinc Coating (Hot-Dip) on Iron and Steel Hardware, Current Edition.
   d. ASTM ~~B221~~A283 - Standard Specification for ~~Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes~~Low and Intermediate Tensile Strength Carbon Steel Plates, Current Edition.

e. ASTM ~~B308~~A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems, Current Edition.

f. ASTM A385 - Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip), Current Edition.

~~e.~~g. ASTM A530 - Standard Specification for ~~Aluminum-Alloy 6061-T6 Standard Structural Profiles~~General Requirements for Specialized Carbon and Alloy Steel Pipe, Current Edition.

h. ASTM ~~B429~~A633 - Standard Specification for ~~Aluminum~~Normalized High-Strength Low-Alloy ~~Extruded~~ Structural ~~Pipe and Tube~~Steel Plates, Current Edition.

i. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel, Current Edition.

~~f.~~j. ASTM B766 - Standard Specification for Electrodeposited Coatings of Cadmium, Current Edition.

3. American Welding Society (AWS) Specifications and Standards, Current Edition.

a. AWS A5.~~10~~1 - Specification for ~~Bare Aluminum and Aluminum-Alloy Welding~~Carbon Steel Electrodes ~~and Rods~~for Shielded Metal Arc Welding, Current Edition.

1.05 SUBMITTALS

A. The Contractor shall submit such submittals and/or catalog cuts required for the construction and installation of the materials. These drawings shall be accurate in every detail and shall contain all information necessary to relate the materials to the specifications.

B. Submittals shall indicate the intended materials arrangement, major support requirements, plot area and all intricate or detailed construction requirements. Information shall be in conformance with requirements of City submittals.

PART 2 PRODUCTS AND MATERIALS

2.01 METAL SURFACES, GENERAL

A. For fabrication of miscellaneous metal work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness.

~~2.02 ALUMINUM ALLOY~~

2.02 ~~Aluminum alloy products, unless otherwise specified, shall be Alloy 6061-T6. Aluminum alloy products~~STEEL

A. Steel for structural components and assemblies shall meet the requirements of the applicable ASTM ~~Standard~~Standards as follows~~.~~:

Product and Material	Standard
~~Sheet and plate~~	~~ASTM B209~~
~~Drawn seamless tubes~~Carbon Steel Plates of Structural Quality	ASTM A283, Grade C
Structural Steel	ASTM ~~B210~~A36
~~Rolled or cold-finished bars, rods and wire~~	~~ASTM B211~~
~~Extruded bars, rods, wire, shapes and tubes~~	~~ASTM B221~~
~~Extruded structural pipe and tube~~	~~ASTM B429~~

2.03 GALVANIZING

A. Zinc coatings on products fabricated from rolled, pressed, and forged steel shapes, plates, bars and strip, 1/8 inch thick and heavier shall conform to ASTM A123.

B. Zinc coatings on assembled steel products shall meet the requirements of ASTM A123 and shall be applied in conformance with ASTM A385 for the recommended practice for providing high quality zinc coatings on assembled products, unless otherwise specified.

C. Zinc coatings on iron and steel hardware shall meet the requirements of ASTM A153, except that bolts, screws and other fasteners, 1/2 inch or less in diameter, may be coated with electro-deposited zinc or cadmium coating meeting the requirements of ASTM B633, Type RS, or ASTM B766, Type TS unless otherwise specified.

D. Hot-Dip Galvanizing Touch-Up Paint: Yield shall be 94% pure zinc metallic powder; meet ASTM B-117-64 salt spray (2000 hours); meets performance requirements of MIL-D-46105 and DOD-P-21035A.
1. Crown Premium 7007 by Aevoe Industries
2. Or equal approved prior to bidding

~~2.03~~2.04 WELDING ELECTRODES

A. ~~Aluminum~~Steel welding electrodes shall conform to the requirements of AWS A5.~~10~~1, "Specification for ~~Aluminum and Aluminum Alloy~~ Mild Steel Covered Arc-Welding ~~Rods and Bare~~ Electrodes~~".~~", except that they shall be uniformly and

heavily coated (not washed) and shall be of such a nature that the coating will not chip or peel while being used with the maximum amperage specified by the manufacturer.

PART 3 CONSTRUCTION METHODS

3.01 QUALITY ASSURANCE

A. Take field measurements prior to preparation of submittals and fabrication, where possible without delay to job progress. Allow for trimming and fitting wherever taking field measurements before fabrication.

B. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation.

3.02 FABRICATION

A. Steel shall be structural quality unless otherwise specified. Castings shall be thoroughly cleaned and subjected to careful inspection before installation. Finished surfaces shall be smooth and true to assure proper fit.

~~B. Fabrication of structural aluminum shall meet the requirements of Sections 6 and 7 of the Aluminum Construction Manual, "Specifications for Aluminum Structures", The Aluminum Association.~~

3.03 PROTECTIVE COATINGS

A. Items specified to be hot-dip galvanized shall be completely fabricated for field assembly before the application of the zinc coatings.

~~B. All aluminum items to be in contact with concrete shall have a bituminous coating.~~

END OF SECTION

SECTION 05 52 00

RAILINGS

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. The work under this section shall cover furnishing and installing all handrails and toe plates at all locations shown on contract drawings and specified herein.

1.02 APPLICABLE PROVISIONS (NONE)

1.03 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

~~1. The Aluminum Association (AA), Specifications and Standards:~~

~~a. AA Sections 6 and 7 – Aluminum Construction Manual, Specifications for Aluminum Structures, Current Edition.~~

~~2. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards:~~

~~a. ASTM B136 – Standard Method for Measurement of Stain Resistance of Anodic Coatings on Aluminum, Current Edition.~~

~~b. ASTM B137 – Standard Test Method for Measurement of Coating Mass Per Unit Area on Anodically Coated Aluminum, Current Edition.~~

~~c. ASTM B209 – Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate, Current Edition.~~

~~d. ASTM B210 – Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes, Current Edition.~~

~~e. ASTM B211 – Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire, Current Edition.~~

~~f. ASTM B221 – Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes, Current Edition.~~

~~g. ASTM B308 – Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles, Current Edition.~~

~~h. ASTM B429 – Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube, Current Edition.~~

~~i. ASTM B457 – Standard Test Method for Measurement of Impedance of Anodic Coatings on Aluminum, Current Edition.~~

~~j. ASTM B580 – Standard Specification for Anodic Oxide Coatings on Aluminum, Current Edition.~~

~~3.~~1. Code of Federal Regulations (CFR), Title 29, Chapter XVII - Occupational Safety and Health Administration (OSHA), Department of Labor, Part 1926 Regulations, Current Edition.

1.04 RELATED WORK ELSEWHERE

A. Metal Fastenings - Division 05

B. Metal Fabrications - Division 05

1.05 SUBMITTALS

A. Contractor shall submit such shop drawings and/or catalog cuts required for the construction and installation of the materials and all components. These drawings shall be accurate in every detail and shall contain all information necessary to relate the materials to the specifications. Submittals shall include test data showing railings comply with OSHA requirements.

B. Submittals shall indicate the intended materials arrangement, dimensions, major support requirements, plot area and all intricate or detailed construction requirements. Information shall be in conformance with requirements of City submittals.

PART 2 PRODUCTS AND MATERIALS

2.01 MATERIALS

A. Railings shall be 1-1/2 inch round, ~~6063 anodized aluminum alloy,~~ASTM A53, Grade B Schedule 40 pipe size. Use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness. Remove such blemishes by grinding or by welding and grinding.

B. Post members shall be one continuous piece and spaced not more than 6-feet on center.

C. Railing and connection shall be designed to resist a 200 pound load applied at any point on the handrail system per OSHA requirements.

PART 3 CONSTRUCTION METHODS

3.01 QUALITY ASSURANCE

A. Take field measurements prior to preparation of shop drawings and fabrication, where possible, without delay to job progress. Allow for trimming and fitting wherever taking field measurements before fabrications.

B. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation.

3.02 FABRICATION

A. Where details are not shown, top of top guardrail shall be 42 inches above floor.

B. Fit and shop assemble components in largest practical sizes, for delivery to site.

C. Fabricate components with joints tightly fitted and secured.

D. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

E. Railings shall have mechanical connections consisting of internal plugs with stainless steel screws or rivets. Railings shall be mechanically fastened to the building structure.

F. Continuously seal joined pieces by continuous welds.

G. Form exposed work true to line and level with accurate angles and surfaces and straight, true edges. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise shown on the contract drawings. Form bent-metal corners to the smallest radius possible without causing grain separation of otherwise impairing the work. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline.

H. Accurately form components, to each other and to ~~building~~ structure.

~~I. Fabrication of structural aluminum shall meet the requirements of Sections 6 and 7 of the Aluminum Construction Manual, "Specifications for Aluminum Structures", The Aluminum Association.~~

3.03 INSTALLATION

A. Perform cutting, welding and fitting required for installation. Set the work accurately in location, alignment and elevation, plumb, level, true and free of rack. Fit exposed connections accurately together to form tight hairline joints.

B. Do not weld, cut or abrade the surfaces of units which have been coated or finished after fabrication, and are intended for field connections.

C. Adjust railings prior to securing in place to ensure proper matching at butting joints and correct alignment throughout their length.

D. Space posts not more than 6 feet on centers, unless otherwise shown on the contract drawings. Plumb posts in each direction. Secure posts and rail ends to building construction as shown on drawings.

E. Expansion joints shall be installed at 24 feet maximum centers.

END OF SECTION

SECTION 07 92 00

JOINT SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preparing sealant substrate surfaces.

B. Sealant and joint backing.

1.02 RELATED SECTIONS

A. Division 03 - Concrete: Sealants used in conjunction with cast-in-place concrete.

B. Division 26 - Electrical: Sealants used in conjunction with electrical penetrations.

C. Section 33 51 13 – Natural-Gas Piping: Sealants used in conjunction with pipe penetrations.

D. Division 40 – Process Integration: Sealants used in conjunction with water, sewer, and wastewater piping penetrations.

E. Division 44 – Pollution Control Equipment: Sealants used in conjunction with process mechanical penetrations.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM) International:
   1. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
   2. ASTM C1193 - Standard Guide for Use of Joint Sealants.
   3. ASTM D1667 - Standard Specification for Flexible Cellular Materials – Poly (Vinyl Chloride) Foam (Closed-Cell).
   4. ASTM D1056 – Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.

B. Sealing and Waterproofers Institute (SWI):
   1. SWI - Sealant and Caulking Guide Specification.

1.04 SUBMITTALS

A. Product Data: Indicate sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.

B. Manufacturer Installation Instructions: Submit special procedures, surface preparation, and perimeter conditions requiring special attention.

C. Warranty: Include coverage for installed sealants and accessories failing to achieve watertight seal, exhibit loss of adhesion or cohesion, and sealants which do not cure.

1.05 QUALITY ASSURANCE

A. Conform to Sealant and Waterproofers Institute requirements for materials.

B. Use adequate numbers of skilled workmen thoroughly trained and experienced in the necessary crafts and completely familiar with the specified requirements and methods needed for proper performance of the work of this Section.

C. Applicator qualifications:
   1. Applicator shall have at least three (3) years experience in installing materials of types specified and shall have successfully completed at least three (3) projects of similar scope and complexity.
   2. Applicator shall designate a single individual as project foreman who shall be on site at all times during installation.

D. Single source responsibility for joint sealants:
   1. Obtain joint sealants from single manufacturer for each different product required to ensure compatibility.
   2. Manufacturer shall instruct applicator in procedures for intersecting sealants.

E. Perform work in accordance with ASTM C1193 guidelines, except where more stringent requirements are indicated or specified.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Material and Equipment.

B. Do not install solvent curing sealants in enclosed building spaces.

C. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.07 PRODUCT STORAGE AND HANDLING

A. Section 01 60 00 - Material and Equipment: Product storage and handling provisions.

B. Deliver the materials to the job site in the manufacturer’s unopened containers with all labels intact and legible at time of use.

C. Store materials in accordance with manufacturer’s recommendations with proper precautions to ensure fitness of material when installed.

1.08 SEQUENCING AND SCHEDULING

A. Section 01 31 13 - Project Coordination: Work coordination provisions.

B. Coordinate the work of this Section with all Sections referencing this Section.

1.09 SUBSTRATE CONDITIONS

A. Provide joints properly dimensioned to receive the approved sealant system.

B. Provide joint surfaces that are clean, dry, sound and free of voids, deformations, protrusions, and contaminants which may inhibit application or performance of the joint sealant.

1.10 WARRANTY

A. Deliver to the Architect signed copies of the following written warranties against adhesive and cohesive failure of the sealant and against infiltration of water and air through the sealed joint for a period of three (3) years from date of completion.
   1. Manufacturer's standard warranty covering sealant materials.
   2. Applicator's standard warranty covering workmanship.

PART 2 PRODUCTS

2.01 GENERAL

A. Compatibility:
   1. Provide joint sealants, joint fillers, and accessory joint materials that are compatible with one another and with joint substrates under project conditions.
   2. Install joint sealants, joint fillers, and related joint materials that are nonstaining to visible joint surfaces and surrounding substrate surfaces.

B. Provide colors selected by Architect from manufacturer's standard color range, unless noted otherwise.

2.02 SEALANTS

A. Polyurethane Sealant:
   1. Tremco Dymeric or BASF MasterSeal NP2.

B. Self-Leveling Polyurethane Sealant:
   1. BASF MasterSeal SL 1, Tremco THC-900, or Vulkem 45SSL.
   2. For areas where the slope of the slab makes self-leveling material impractical BASF MasterSeal SL 2, Tremco THC-901, or Vulkem 45SSL may be used.
   3. Color: Match concrete color.

2.03 ACCESSORIES

A. Primer: Non-staining type, as recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive and non-staining type, as recommended by sealant manufacturer; compatible with joint forming materials.

C. Backer Rod: Polyethylene foam rod or rope or other compatible non-waxing, non-extruding, non-staining resilient material as recommended by sealant manufacturer, closed cell, sized 25 percent wider than joint width.

D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

E. Masking Tape: Non-staining, non-absorbent tape product compatible with joint sealants and adjacent joint surfaces that is suitable for masking.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that joint openings are ready to receive work and field measurements are as shown on Drawings and recommended by the manufacturer.

B. Beginning of installation means acceptance of substrates.

3.02 PREPARATION

A. Prepare surfaces to receive sealants in accordance with sealant manufacturer's instructions and recommendations.

B. Examine joint sizes and correct as required to allow for anticipated movement and to achieve proper width/depth ratio per manufacturer's recommendations for specified sealant.

C. Thoroughly clean joint surfaces using cleaners approved by sealant manufacturer, whether primers are required or not.
   1. Remove all traces of previous sealant and joint backer by mechanical methods, such as by cutting, grinding and wire brushing, in manner not damaging to surrounding surfaces.
   2. Remove paints from joint surfaces except for permanent, protective coatings.
   3. Remove wax, oil, grease, dirt film residues, temporary protective coatings and other residues by wiping with cleaner recommended for that purpose. Use clean, white, lint-free cloths and change cloths frequently.
   4. Remove loose materials and foreign matter.
   5. Remove dust by blowing clean with oil-free, compressed air.

D. Verify that joint backing and release tapes are compatible with sealant.

E. Measure joint dimensions and size materials to achieve required width/depth ratios.

F. Protect elements surrounding the work of this Section from damage or disfiguration.

3.03 INSTALLATION

A. Install sealant in accordance with manufacturer's instructions, and SWI "Sealant: The Professional's Guide".

B. Where necessary to protect adjacent surfaces, mask adjacent surfaces with tape prior to priming and/or caulking.
   1. Use masking tape where required to prevent sealant or primer contact with adjoining surfaces that would be permanently stained or otherwise damaged by such contact or the cleaning methods required for removal.
   2. Apply tape so as not to shift readily and remove tape immediately after tooling without disturbing joint seal.

C. Provide backer rod uniformly to depth required by sealant manufacturer for proper joint design using a blunt instrument.
   1. Fit securely by compressing backer material 25 percent to 50 percent so no displacement occurs during tooling.
   2. Avoid stretching or twisting joint backer.
   3. Install to achieve a neck dimension no greater than 1/3 the joint width.

D. Install bond breaker where backer rod is not used or where recommended by sealant manufacturer, adhering strictly to the manufacturers installation requirements.

E. Prime joint substrates where required.
   1. Use and apply primer according to sealant manufacturers recommendations.
   2. Confine primers to sealant bond surfaces; do not allow spillage or migration onto adjoining surfaces.
   3. Prime immediately prior to caulking.

F. Install sealants immediately after joint preparation.

G. Install sealants to fill joints completely from the back, without voids or entrapped air, using proven techniques, proper nozzles, and sufficient force that result in sealants directly contacting and fully wetting joint surfaces.

H. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

I. Install sealants to uniform cross-sectional shapes with depths relative to joint widths that allow optimum sealant movement capability as recommended by sealant manufacturer.

J. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

K. Tool sealants in manner that forces sealant against back of joint, ensures firm, full contact at joint interfaces and leaves a finish that is smooth, uniform and free of ridges, wrinkles, sags, air pockets and embedded impurities. Provide concave tooled joints.

L. Remove sealant from adjacent surfaces in accord with sealant and substrate manufacturer recommendations as work progresses.

M. Protect joint sealants from contact with contaminating substances and from damages. Cut out, remove, and replace contaminated or damaged sealants, immediately, so that they are without contamination or damage at time of substantial completion.

N. Clean adjacent surfaces immediately and leave work neat and clean. Remove excess and droppings using recommended cleaners as work progresses. Remove masking tape immediately after tooling of joints.

3.04 CLEANING AND REPAIRING

A. Clean adjacent soiled surfaces.

B. Repair or replace defaced or disfigured finishes caused by work of this Section.

3.05 PROTECTION OF FINISHED WORK

A. Protect sealants until cured.

END OF SECTION

SECTION 09 96 00

HIGH PERFORMANCE COATINGS

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

A. Work includes field painting of all exposed gas piping and preparation of surfaces to receive coatings.

1.02 WORK NOT INCLUDED

A. Pre-Finished Items: Unless otherwise indicated, do not paint factory-finished or pre-finished items.

B. Operating Parts: Do not paint any moving parts of operating units, mechanical and electrical parts such as valve operators, unless otherwise directed or; machined or polished surfaces of equipment where such surfaces are susceptible to rolling or sliding friction.

C. Labels: Do not paint over any required labels, such as Underwriters' Laboratories and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates. (This does not include cast or embossed names on equipment castings.)

1.03 APPLICABLE PROVISIONS (NONE)

1.04 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards:
   a. ASTM D16 - Definitions of Terms Relating to Paint, Varnish, Lacquer and Related Products, Current Edition.
2. Steel Structures Painting Council (SSPC), Specification and Standards:
   a. Steel Structures Painting Manual, Volume 2, "Systems & Specifications", Current Edition.

1.05 RELATED WORK ELSEWHERE

A. Section 33 51 13 – Natural-Gas Piping

1.06 DELIVERY, STORAGE, AND HANDLING

A. Material and Equipment: Product storage and handling provisions.

B. Deliver products to site in sealed and labeled containers; inspect to verify acceptance.

C. Container labeling to include manufacturer's name, type of paint, brand name, brand code, coverage, surface preparation, drying time, cleanup, color designation, and instructions for mixing and reducing.

D. Paint Materials: Store paint materials at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in well ventilated area, unless required otherwise by manufacturer's instructions.

E. Store products in ventilated dry areas, protected from contract with soil and from exposure to the elements; keep products dry at all times; restrict storage to paint materials and related equipment; comply with health and fire regulations.

F. Take precautionary measures to prevent fire hazards and spontaneous combustion.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Material and Equipment: Environmental provisions.

B. Do not apply materials when surface and ambient temperatures are outside temperature ranges required by paint product manufacturer.

C. Do not apply exterior coatings during rain or snow, or when relative humidity is above 50 percent, unless required otherwise by manufacturer's instructions.

D. Minimum Application Temperatures for Paints: 50 degrees F, unless required otherwise by manufacturer's instructions.

1.08 CLOSEOUT SUBMITTALS

A. Closeout Procedures: Project closeout provisions.

1.09 EXTRA MATERIAL

A. Closeout Procedures: Extra material provisions.

B. Provide one (1) unopened quart container to Owner.

C. Label each container with color, texture, and room locations in addition to the manufacturer's label.

PART 2 PRODUCTS AND MATERIALS

2.01 ACCEPTABLE MANUFACTURERS

A. The products listed are intended to establish a basis for comparison of products of other manufacturers. Substitutions will be permitted but only with the prior written approval of the Engineer.

B. All materials specified herein, and approved for use under this Contract shall be manufactured by one of the Manufacturers listed as follows: Tnemec, Carboline, Ameron, Dupont, Sherwin-Williams, or equal.

2.02 MATERIALS

A. Provide the best grade (quality) of the various types of coatings as regularly manufactured by approved paint materials manufacturers. Materials not displaying the manufacturer's identification as a standard, best-grade product will not be acceptable. Refer to the "PAINTING/COATING SCHEDULE" in this section for the types of paint and finishes to be applied to the various surfaces throughout the project.

B. Use only thinners recommended by the manufacturer and then only to the extent expressed on the latest printed data sheet.

PART 3 CONSTRUCTION METHODS

3.01 JOB CONDITIONS

A. Environmental Requirements: Comply with manufacturer's recommendations as to environmental conditions under which coating and coating systems may be applied. Do not apply paint in areas where dust is being generated.

B. Protection: Cover or otherwise protect finished work, surfaces not being painted concurrently, or not to be painted.

C. Factory Painted Surfaces: The surface preparation and painting of materials and equipment will be to manufacturer's standard unless otherwise specified in applicable portions of these specifications.

3.02 SUBSTRATE EXAMINATION

A. Examine all surfaces to which paint is to be applied, and the conditions under which the work is to be performed. The Applicator shall notify the Contractor and Engineer in writing, of any conditions detrimental to the performance of this work.

B. Do not proceed with this work until unsatisfactory conditions have been corrected and are acceptable to the Applicator. Starting of painting work will be construed as the Applicator's acceptance of the surfaces and conditions.

3.03 SURFACE PREPARATION, GENERAL

A. Perform preparation and cleaning procedures in strict accordance with the paint manufacturer's instructions and as herein specified, for each particular substrate condition.

B. Remove all hardware, hardware accessories, machined surfaces, plates, and similar items not to be painted, or provide surface applied protection prior to preparation and painting operations. Remove obstructions as necessary to permit complete painting of the items and adjacent surfaces. Following completion of painting of each space or area, install the removed items by workmen skilled in the trades involved.

C. Clean surfaces to be painted before applying surface treatments. Remove oil and grease prior to mechanical cleaning. Program the cleaning and painting so that contaminants from the cleaning process will not fall onto wet, newly painted surfaces.

3.04 PREPARATION, FERROUS METALS

A. Wash steel and iron surfaces with turpentine or mineral spirits to remove dirt and grease. Where rust or scale is present, prepare surface in accordance with the requirements as specified below:
   1. Clean galvanized metal surfaces with turpentine or mineral spirits to remove oily residue. Dry with a clean cloth;
   2. Touch-up paint structural steel, miscellaneous metal, hollow metal doors and frames and other materials which have been prime coated, as required, where shop coat has been damaged by welding or handling and erection; paint rivets, bolts and welds which are unpainted after assembly and erection.
   3. Prepare steel substrates in accordance with the Steel Structures Painting Council surface preparation number indicated in the application schedule and as outlined below, unless otherwise required by the paint manufacturer's most recent printed application instructions:
      a. SSPC-SP-1-thoroughly wipe with aromatic/ketone solvent using clean rags and solvent;
      b. SSPC-SP-6-good Commercial Finish;
      c. SSPC-SP-7-surface Brush Blast using fine sand or grit to obtain finish similar to medium sand paper;
      d. SSPC-SP-10-surface blast Near-White Metal Finish.

B. Apply primer immediately after surface preparation. Clean and touch up shop primer that has become marred.

3.05 MATERIAL PREPARATION

A. Mix and prepare painting materials in accordance with the manufacturer's directions. Stir materials before application to produce a mixture of uniform density, and stir as

required during the application of the materials. Do not stir surface film into the material. Remove the film and, if necessary, strain the material before using.

3.06 COLORS

A. Intermediate coats of paint shall be tinted slightly darker than each preceding coat unless otherwise directed. Undercoats shall be tinted slightly lighter than finish coats.

3.07 APPLICATION

A. Apply paint in accordance with the manufacturer's directions. Use applicators and techniques best suited for the type of material being applied.

B. Apply each coat at the rate specified by the manufacturer; if material has thickened or must be diluted for application by spray gun, build up coat to the same film thickness achieved with undiluted material; correct deficiencies in film thickness by application of additional coats of paint.

C. Do not apply exterior paint in cold, foggy, damp or rainy weather. Do not apply paint when temperature is lower than 50 degrees Fahrenheit.

D. Brush or roll materials smoothly in solid, even colors without drops, runs, lumps, defective brushing, discoloration or clogging of lines and angles. Make edges of paint adjoining other materials or colors sharp and clean without overlapping by masking edges of paint adjoining other materials or colors to obtain sharp, clean division.

E. Coats shall be thoroughly dry before applying succeeding coats. Unless otherwise approved, allow 48 hours minimum drying time between coats for interior work during favorable drying conditions. (Drying time shall be construed to mean "under normal conditions"; where conditions are other than normal because of weather or because painting must be done in confined spaces, longer drying times will be required.) Do not apply additional coats of paint or place unit in service until paint is thoroughly dry.

F. Where thinning is necessary, only the products of the manufacturer furnishing the paint, and for the particular purpose, will be allowed; thin paint in strict accordance with the manufacturer's instructions and only with the full knowledge and approval of the Engineer.

G. Do not apply finish coats until after other trades, whose operations would be detrimental to finish painting, have completed work in the areas to be painted, and the areas have been approved by the Engineer for painting.

H. At completion, touch up and restore finish where damaged.

3.08 PROTECTION

A. Protect work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct any damages by cleaning, repairing or replacing, and repainting, as directed by the Engineer. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.

3.09 CLEAN-UP

A. During the progress of the work, remove from the project all discarded paint materials, rubbish, cans and rags. Upon completion of painting work, clean all window glass and other paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

3.10 PAINTING SCHEDULE

A. Gas Piping:
   1. Surface Preparation: Blast to the extent of an SSPC-SP-6 Commercial-Grade level of cleanliness and prime before any rust bloom reforms.
   2. Primer: Spray apply one even coat of Manufacturer, Color, Polyamidoamine Epoxy, to a DFT of 5.0 mils.
      a. Dupont 25P
      b. Tnemec Series 69
      c. Carboline 890
      d. Ameron Amerlock 400
      e. Sherwin Williams Macropoxy 646
   3. Intermediate: Spray apply one even coat of Manufacturer, Color, Polyamidoamine Epoxy, to a DFT of 5.0 mils.
      a. Dupont 25P
      b. Tnemec Series 69
      c. Carboline 890
      d. Ameron Amerlock 400
      e. Sherwin Williams Macropoxy 646
   4. Field Finish: Apply one field finish coat of Manufacturer, Color, Acrylic Polyurethane, to a minimum DFT of 2.0 to 3.0 mils.
      a. Dupont 326 Imron
      b. Tnemec Series 73
      c. Carboline Carbothane 134 HG
      d. Ameron Amershield
      e. Sherwin Williams Acrolon 218

3.11 COLORS SCHEDULE

A. Paint for components listed shall be of the colors scheduled as follows:

COMPONENT	COLOR
1. Gas Piping, Natural	Orange

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
    a. ANSI/NFPA 70 - National Electrical Code (NEC) and state amendments thereto.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. International Society of Automation (ISA)
6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition.
7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), current edition.
    a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
10. International Electrical Testing Association (NETA)
    a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
11. Canadian Standards Association (CSA), Specifications and Standards, current edition.
12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
13. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.

1.03 DESCRIPTION OF WORK

A. General Requirements

1. Furnish and install complete and operable electrical systems as indicated on the drawings and as specified herein. This includes everything necessary for and incidental to completing the electrical work as specified including but not limited to the following.
2. Provide all electrical work, including conduit, field wiring, and connections by the electrical subcontractor under the provisions of the Electrical Specifications for all aspects of the work, including heating, ventilating, and air conditioning.
3. Coordinate all aspects of the work with the electrical subcontractor and other subcontractors before bidding in order to ensure that all costs associated with a complete installation are included. The owner is not responsible for any change orders due to lack of coordination of the contractor, the electrical subcontractor, the other subcontractors, or suppliers.
4. Provide all trenching, forming, rebar, concrete, back filling, hard surface removal and replacement, for all items associated with the electrical work and installation.

B. Design Requirements:
1. The Conduit and Boxes table included in the plan set specifies the usage requirements for the hardware and equipment specified in the following sections:
   a. Section 26 05 29 Hangars and Supports for Electrical Systems
   b. Section 26 05 34 Conduit
   c. Section 26 05 37 Boxes

C. Electrical Work Specified Elsewhere:
1. Every attempt has been made to indicate in these specifications and drawings all work required under Division 26. However, there may be additional specific requirements in the specifications, drawings, or addenda of other trades which pertain to the work of this trade, and any such requirements are hereby made a part of the requirements for this trade.

D. Design Intent:
1. The Contractor shall furnish and install all the necessary materials, apparatus, and devices to complete the electrical equipment and systems installation herein specified, except such parts as are specifically exempted herein.
2. If an item is either called for in the specifications or shown on the plans, it shall be considered sufficient for the inclusion of said item in this contract. If a conflict exists within the Specifications or Drawings, the Contractor shall furnish the item, system, or workmanship that is the highest quality, largest, or most closely fits the design intent.
3. Refer to the General Conditions of the Contract for further clarification of Design Intent.

4. The details and drawings are diagrammatic. The Contractor shall verify all dimensions at the site and be responsible for their accuracy.
5. All sizes as given are minimum except as noted.
6. Materials and labor shall be new (unless noted or stated otherwise), first class, and workmanlike, and shall be subject at all times to inspections, tests and approval from the commencement until the acceptance of the completed work.
7. Electrical requirements for equipment are based on design data. It shall be the responsibility of the Contractor to verify actual requirements with the provider of the equipment and adjust electrical installation based upon actual requirements.

E. Substitution of Materials:
1. Refer to General Conditions of the Contract.
2. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the Contractor is responsible for all costs involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the specified performance from the system into which these items are placed.

F. Continuity Of Existing Services And Systems:
1. No outages shall be permitted on existing systems except at the time and during the interval(s) coordinated and approved by the Owner and the Engineer. Any outage must be scheduled when the interruption causes the least interference with normal schedules and routines. No extra costs will be paid to the Contractor for such outages that must occur outside of regular weekly working hours.
2. This Contractor shall restore any circuit interrupted as a result of this work to proper operation as soon as possible.
3. Contractor shall submit plan for owner and engineer review detailing the proposed sequencing of the installation as it pertains to the continuity of electrical service.

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

F. Earthwork – Division 31

G. Utilities – Division 33

1.05 SUBMITTALS

A. Submit shop drawings.

B. Submittal Requirements for Division 26 Shop Drawings:
   1. Submit individual shop drawings for each section requiring submittal.
   2. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents.
   3. Mark dimensions and values in units to match those specified. Include wiring diagrams of electrically powered or controlled equipment.
   4. Clearly notate any exceptions taken to these specifications.
   5. Do not release equipment for construction until submittal has been reviewed and received engineer approval.
   6. Failure to comply with these requirements does not relieve the Contractor of responsibility for meeting the project schedule.

C. Review of shop drawings shall be for conformance with design concept only and will not release the Contractor from fulfilling the terms and intent of the contract documents.

D. Shop Drawings shall be prepared and submitted for the following work:
   1. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less)
   2. Section 26 05 26 – Grounding and Bonding for Electrical Systems
   3. Section 26 05 29 - Hangers and Supports for Electrical Systems
   4. Section 26 05 34 - Conduit
   5. Section 26 05 37 – Boxes
   6. Section 26 05 41 – Wiring Devices
   7. Section 26 05 53 – Identification for Electrical Systems
   8. Section 26 05 73 – Electrical Systems Analysis
   9. Section 26 09 07 – Automatic Transfer Control
   10. Section 26 24 16 – Panelboards
   11. Section 26 28 11 – Circuit Breakers
   12. Section 26 29 13 – Motor Controllers
   13. Section 26 32 13 – Standby Engine Generator Set
   14. Section 26 36 23 – Transfer Switch
   15. Section 26 43 13 – Surge Protection
   16. Section 26 90 00 - Process Instrumentation & Control
   17. Section 26 90 10 – Control Panel Construction
   18. Section 26 90 11 – Control Panel Components
   19. Section 26 90 30 – Programmable Logic Controllers
   20. Section 26 90 60 – Ethernet Networking Equipment

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation & maintenance manuals.

B. Submittal Requirements for Division 26 Operation/Maintenance Manuals and Instructions:

1. Assemble material in three-ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to the data indicated in the General Requirements, include the following information:
    a. Copies of as-built shop drawings.
    b. Wiring diagrams for electrically powered or controlled equipment. Drawings to be supplied on 11-inch by 17-inch paper.
    c. Records of tests performed to certify compliance with system requirements
    d. Certificates of inspection by regulatory agencies
    e. Parts lists for manufactured equipment
    f. Preventive maintenance recommendations
    g. Warranties
    h. Additional information as indicated in the technical specification sections
        1) Test Reports and Demonstration Log:
            a) Permanently record checks and tests and demonstrations.
            b) Submit copy of complete testing or demonstration report no later than 30 days after testing or demonstration is complete.

C. Operation & Maintenance Manuals and Instructions shall be prepared and submitted for the following equipment:

1. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less)
2. Section 26 05 26 – Grounding and Bonding for Electrical Systems
3. Section 26 05 29 - Hangers and Supports for Electrical Systems
4. Section 26 05 34 - Conduit
5. Section 26 05 37 – Boxes
6. Section 26 05 41 – Wiring Devices
7. Section 26 05 53 – Identification for Electrical Systems
8. Section 26 05 73 – Electrical Systems Analysis
9. Section 26 09 07 – Automatic Transfer Control
10. Section 26 24 16 – Panelboards
11. Section 26 28 11 – Circuit Breakers
12. Section 26 29 13 – Motor Controllers
13. Section 26 32 13 – Standby Engine Generator Set
14. Section 26 36 23 – Transfer Switch
15. Section 26 43 13 – Surge Protection

16. Section 26 90 00 - Process Instrumentation & Control
17. Section 26 90 10 – Control Panel Construction
18. Section 26 90 11 – Control Panel Components
19. Section 26 90 30 – Programmable Logic Controllers
20. Section 26 90 60 – Ethernet Networking Equipment

1.07 FACTORY TESTING

A. Refer to the requirements the individual technical sections.

1.08 QUALITY ASSURANCE

A. All work and materials shall conform to or exceed in every detail the applicable rules and requirements of the Wisconsin State Electrical Code Volumes 1 and 2, the National Electrical Code (ANSI/NFPA 70), other applicable National Fire Protection Association standards, the National Electrical Safety Code, and present manufacturing standards.

B. All work shall be performed under the direction of a State of Wisconsin Licensed Master Electrician.

C. All materials shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system shall be so labeled.

D. The following laboratories are approved for providing electrical product safety testing and listing services as required in these specifications:
   1. Underwriters Laboratories Inc.
   2. Electrical Testing Laboratories, Inc.

E. Certificates And Inspections:
   1. Refer to the General Conditions of the Contract.
   2. Obtain and pay for all required inspections including but not limited to state or local electrical inspections and fuel tank inspections. Deliver original inspection certificates to the Engineer.

1.09 WARRANTY

1.10 EXTRA MATERIALS

1.11 MAINTENANCE

A. Before substantial completion, perform all maintenance activities required by any sections of the specifications including any calibrations, final adjustments,

component replacements or other routine service required before placing equipment or systems into service.

B. Furnish all spare parts as required by other sections of the specifications.

PART 2 PRODUCTS AND MATERIALS

2.01 ACCESS PANELS AND DOORS

A. Lay-in Ceilings:
1. Removable lay-in ceiling tiles in 2 x 2 foot or 2 x 4 foot configuration are sufficient; no additional access provisions are required unless specifically indicated.

B. Drywall and Plaster Walls and Ceilings:
1. 16 gauge frame with not less than a 20 gauge hinged door panel, prime coated steel for general applications, stainless steel for use in toilets, showers and similar wet areas, concealed hinges, screwdriver operated cam latch for general application, key lock for use in public areas, UL listed for use in fire rated partitions if required by the application. Use the largest size access opening possible, consistent with the space and the equipment needed service; minimum size is 12 x 12 inch.

2.02 SEALING AND FIRE-STOPPING

A. Refer to Architectural requirements.

B. Sealing and fire stopping of sleeves/openings between conduits, cable trays, wire ways, troughs, cable bus, bus duct, etc. and the structural or partition opening shall be the responsibility of the Contractor whose work penetrates the opening. Individuals skilled in such work shall perform the sealing and fire stopping.

C. Whenever possible, avoid penetrations of fire and smoke rated partitions. When they cannot be avoided, verify that sufficient space is available for the penetration to be effectively fire and smoke stopped.

D. Manufacturers:
1. 3M, STI/SpecSeal, Tremco, or approved equal.
2. The same manufacturer shall provide all fire stopping systems.
3. The Contractor will be responsible for selecting the appropriate UL tested fire stop system for each application required on the project.

E. Use a product that has a rating not less than the rating of the wall or floor being penetrated. Reference architectural drawings for identification of fire and/or smoke rated walls and floors.

F. Contractor shall use fire stop putty, caulk sealant, intumescent wrap strips, intumescent fire stop collars, fire stop mortar or a combination of these products to provide a UL listed system for each application required for this project. Provide mineral wool backing where specified in manufacturer's application detail.

2.03 NON-RATED PENETRATIONS

A. Conduit Penetrations Through Concrete Wall and Foundation:
1. In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated conduit and the cored opening or a water-stop type wall sleeve.

B. Conduit and Cable Tray Penetrations:
1. At conduit and cable tray penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between conduit and sleeve, or the core drilled opening.

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK

A. The Contractor shall be responsible for coordinating conductor marking and color coding requirements with control system equipment supplier(s).

3.02 FIELD MEASUREMENTS

A. The Contractor shall obtain from the appropriate trades and review shop drawings for all equipment requiring electrical connections.

B. Field verify all measurements. Do not base electrical installation or equipment locations on the contract drawings. Actual field conditions govern all final installed locations, distances, and levels.

C. Identify conflicts with the work of other trades prior to installation of electrical system.

D. Electrical installation shall be based upon shop drawing requirements and field verified measurements. Adjust electrical system installation to satisfy field requirements.

3.03 DELIVERY, STORAGE, AND HANDLING

A. Accept electrical equipment on site. Inspect for damage.

B. Take precautions to protect electrical equipment from weather, corrosion, and entrance of debris.

3.04 INSTALLATION

A. Excavation And Backfill:
   1. Perform all excavation and backfill work to accomplish indicated electrical systems installation in accordance with other sections of this specification.

B. Concrete Work:
   1. Coordinate the quantity and location of all cast-in-place concrete work with the architectural drawings.
   2. All cast-in-place concrete will be performed by the General Contractor unless noted otherwise. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for the support of electrical equipment.

C. Cutting And Patching:
   1. Cutting, patching, channeling, and core drilling shall be performed in accordance with the requirements for architectural work.
      a. Secure the permission of the Engineer before performing any operation likely to affect the strength of a structural member.
      b. Before cutting, channeling, or core drilling any surface, ensure that no penetration of any other systems will be made.
   2. Perform all patching to the same quality and appearance as the original work. Employ the proper tradesmen to secure the desired results. Seal around all conduits, wires, and cables penetrating walls, ceilings, and floors in all locations with a fire stop material.
   3. Seal around conduit penetrations of below grade walls with a waterproof, non-shrink, non-metallic grout, unless otherwise indicated on the typical installation detail.

D. Building Access:
   1. Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this Contractor, restore any opening to its original condition after the apparatus has been brought into the building.

E. Equipment Access:
   1. Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance. Coordinate the exact location of wall and ceiling access panels and doors, making sure that access is available for all equipment and specialties. Where access is required in plaster or drywall walls or ceilings, furnish access doors and arrange for installation by appropriate trades.

F. Working Clearances:
   1. Minimum installed equipment working clearances as required by the NEC shall be maintained.

2. Minimum required dedicated electrical equipment space as required by the NEC shall be maintained.
3. Coordinate these requirements with the work of other trades.
4. Identify conflicts with working space requirements prior to installation of equipment.

G. Coordination:
1. Cooperate with other trades in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the electrical work to better fit the general installation, such work shall be done at no extra cost to the Owner. The Contractor shall check location of electrical outlets with respect to other installations before installing.
2. Verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, light fixtures, panel boards, devices, etc. and recessed or semi-recessed heating units installed in/on architectural surfaces.
3. Coordinate all work prior to installation. Any installed work that is not coordinated and that interferes with the work of another trade shall be removed or relocated at no additional cost to the Owner.
4. Verify the integrity of fire or smoke ratings where penetrations are required.

H. Sleeves:
1. Process Equipment Areas:
    a. New poured concrete construction: cast in place, Schedule 40, PVC sleeve.
    b. All other construction: core drill sleeve openings large enough to insert Schedule 40 PVC sleeve and grout around the sleeve.
    c. Floor penetrations:
        1) Extend top of sleeve two inches above the floor.
        2) Where installation of sleeve in floor is not practical, provide two inch deep housekeeping pad extending three inches around cast in place conduits.
    d. Hazardous locations:
        1) Sleeve(s) shall be installed per engineer details.
        2) Sleeve(s) shall be properly sealed to protect against the passage of flammable gases.
2. Non-Process Equipment Areas:
    a. Hollow walls: Schedule 40, PVC sleeves, grout around sleeve in masonry construction.
    b. All other Areas: core drill sleeve openings large enough to insert Schedule 40 PVC sleeve and utilize the core drilled opening as the sleeve.
3. Conduit Support:
    a. If the pipe penetrating the sleeve is supported by a pipe clamp resting on the sleeve, weld a collar or struts to the sleeve that will transfer weight to the floor structure.

I. Sealing And Firestopping:

1. Fire and/or Smoke Penetrations:

a. Install approved product in accordance with the manufacturer's instructions where a pipe (i.e. cable tray, bus, cable bus, conduit, wire way, trough, etc.) penetrates a fire rated surface.

b. Where fire stop mortar is used to infill large fire-rated floor openings that could be required to support weight, provide permanent structural forming. Fire stop mortar alone is not adequate to support any substantial weight.

2. Non-Rated Surfaces:

a. When the opening is through a non-fire rated wall, floor, ceiling or roof the opening must be sealed using an approved type of material.

b. b. Install escutcheons or floor/ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces for this paragraph include only those rooms with finished ceilings and the penetration occurs below the ceiling.

c. In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the conduit and tighten in place, in accordance with the manufacturer's instructions.

d. At interior partitions, conduit penetrations are required to be sealed for all areas. Apply sealant to both sides of the penetration in such a manner that the annular space between the conduit sleeve and the conduit is completely filled.

J. Housekeeping and Clean-up

1. On a daily basis, clean up and remove all debris and rubbish resulting from work and repair all damage to new and existing equipment resulting from work.

2. Remove all tools, excess material, and unused equipment from the site when job is complete.

K. General Inspection and Cleaning of Electrical Equipment

1. Inspect for physical damage and abnormal mechanical or electrical conditions.

2. Any item found to be out of tolerance, or in any other way defective as a result of the required testing, shall be reported to the Engineer. Procedure for repair and/or replacement will be outlined. After appropriate corrective action is completed the item shall be re-tested.

3. Compare equipment nameplate information with the Contract Drawings and report any discrepancies.

4. Verify proper auxiliary device operation and indicators.

5. Check tightness of accessible bolted electrical joints. Use torque wrench method.

6. Make a close examination of equipment and remove any shipping brackets, insulation, packing, etc. that may not have been removed during original installation.

7. Make a close examination of equipment and remove any dirt or other forms of debris that may have collected in existing equipment or in new equipment during installation.
8. Vacuum inside of panelboards, switchboards, switchgear, transformer core and coils, horizontal and vertical busducts, MCC's, control panels, and any other similar equipment
9. Clean All Equipment:
    a. Loosen attached particles and vacuum them away.
    b. Remove any remaining packing material adhesives with suitable cleaning solution.
    c. Touch-up factory applied finishes damaged during installation using manufacturer approved means to match original finish.

3.05 TESTING AND START-UP SERVICES

A. Refer to the requirements the individual technical sections.

B. Make adjustments to the systems furnished under Division 26 in accordance with the equipment manufacturers requirements/recommendations.

3.06 TRAINING

A. Refer to the requirements the individual technical sections.

END OF SECTION

SECTION 26 05 01

ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs.

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
2. NFPA 70 - National Electrical Code, (NEC) and state amendments thereto.
3. ASTM International (ASTM)
4. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
5. Insulated Cable Engineers Association (ICEA)
6. International Society of Automation (ISA)
7. National Electrical Manufacturers Association (NEMA)
8. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
9. Wisconsin Department of Safety and Professional Services (DSPS)
10. National Electrical Contractors Association (NECA), current edition.
    a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
11. International Electrical Testing Association (NETA)
    a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
12. Canadian Standards Association (CSA), Specifications and Standards, current edition.
13. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
14. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.

1.03 DESCRIPTION OF WORK

A. General Requirements

1. Furnish labor and materials to demolish and remodel existing electrical systems as indicated on the drawings and as specified herein. Design Intent:

2. Every effort has been made to identify major demolition and remodeling work required as part of this project. There may, however be minor work items not specifically identified for demolition or remodeling.
3. The Contractor shall thoroughly review the demolition drawings and shall include work associated with demolition and remodeling of minor items such as receptacles, exit lights, and control stations affected by the work shown on the demolition drawings.
4. Because of the demolition and remodeling work required as part of this project, the Contractor is required to investigate the extent of work on site prior to bidding. Failure to perform this investigation will not relieve the Contractor of responsibility for demolition and remodeling of the minor work items described.

B. Construction Methods:
1. Where detailed construction methods are identified for demolition and remodeling of electrical equipment (for example, methods for implementing service change), it is not intended that the methods proposed be the only acceptable methods for completing the work. The Contractor is encouraged to investigate and propose alternate methods which simplify the work.
2. Alternate methods shall be reviewed by the Engineer prior to commencing the work.
3. Only alternate methods which adequately accomplish the goals of the specified methods will be allowed.

C. Contractor shall furnish labor and materials to demolish all existing electrical gear. All equipment shall be delivered in good condition by the contractor to the Nine Springs Wastewater Treatment Plant at 1610 Moorland Road in the City of Madison. The contractor shall provide two full work days for MMSD to salvage other equipment once the station is off-line. The contact from MMSD regarding salvaging equipment is contact Dan McAdams at MMSD at 608-222-1201 ext 248

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

F. Earthwork – Division 31

G. Utilities – Division 33

1.05 SUBMITTALS – (NOT USED)

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NOT USED)

1.07 FACTORY TESTING (NOT USED)

1.08 QUALITY ASSURANCE

A. All work and materials shall conform to or exceed in every detail the applicable rules and requirements of the Wisconsin State Electrical Code Volumes 1 and 2, the National Electrical Code (ANSI/NFPA 70), other applicable National Fire Protection Association standards, the National Electrical Safety Code, and present manufacturing standards

B. All materials and labor required under this section shall be compatible with existing equipment and conditions.

1.09 WARRANTY (NOT USED)

1.10 EXTRA MATERIALS (NOT USED)

1.11 DESIGN REQUIREMENTS (NOT USED)

1.12 MAINTENANCE (NOT USED)

PART 2 PRODUCTS AND MATERIALS (NOT USED)

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK

A. Contractor shall be responsible for coordinating demolition with subcontractors or other trades.

3.02 FIELD MEASUREMENTS

A. Field verify all measurements. Do not base electrical installation or equipment locations on the contract drawings. Actual field conditions govern all final installed locations, distances, and levels.

B. Verify all circuiting arrangements

C. Verify that abandoned wiring and equipment serve only abandoned facilities.

D. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Engineer before disturbing existing installation.

E. The Contractor shall review demolition drawings and existing conditions for the extent of demolition work required.

F. Commencement of demolition work indicates that Contractor accepts existing conditions and fully comprehends the extent of demolition work.

3.03 DELIVERY, STORAGE, AND HANDLING (NOT USED)

3.04 INSTALLATION

A. Preparation
   1. Identify existing electrical equipment which is to be removed.
   2. Identify existing electrical equipment which is to remain but will be affected by demolition or new construction work.
   3. Identify existing equipment which is to be removed and which the Owner wishes to retain. Owner shall have first right to all removed equipment not specifically being re-used. If Owner retains equipment, Contractor shall transport to designated storage facility located on site. If Owner refuses equipment, Contractor shall be responsible for disposal.
   4. Identify damaged or inoperable existing equipment prior to performing work.
   5. Coordinate utility service outages with user and engineer as well as the Utility Company if applicable.
   6. Maintain access to existing electrical installations, which are to remain active.
   7. Utilize materials and methods compatible with existing electrical installations. Verify existing requirements for compatibility.

3.05 GENERAL DEMOLITION OF ELECTRICAL WORK

A. Demolition of Electrical Work, Structure Modified:
   1. This paragraph defines requirements for electrical demolition where the surfaces or areas containing the work are to be removed.
   2. Disconnect electrical equipment which is to be removed.
   3. Remove surface mounted and free-standing electrical equipment.
   4. Remove existing wiring to source of supply.
   5. Remove surface mounted conduits and raceways.
   6. Disconnect concealed conduits from equipment which is to remain.
   7. Concealed conduits may be removed with structure which is to be removed.
   8. Transport Owner retained equipment to on-site location as directed by Owner.

9. Dispose of all other removed equipment.

B. Demolition of Electrical Work, Structure Not Modified:
1. This paragraph defines requirements for electrical demolition where the surfaces or areas containing the work are to remain.
2. Disconnect electrical equipment which is to be removed.
3. Remove surface mounted and free-standing electrical equipment.
4. Remove existing wiring to source of supply.
5. Remove surface mounted conduits and raceways.
6. Concealed conduit which is abandoned shall be cut flush with walls and floors. Patch surfaces to match existing finish.
7. Transport Owner retained equipment to on-site location as directed by Owner.
8. Dispose of all other removed equipment.

3.06 GENERAL REMODELING OF ELECTRICAL WORK

A. Reconnection of Electrical Equipment
1. This paragraph defines requirements for electrical remodeling where the conduit and/or conductors connecting existing equipment must be replaced because of remodeling work in the area.
2. Thoroughly investigate existing wiring and conduit to determine requirements for reconnection.
3. Provide temporary wiring and connections to maintain existing systems in service during construction. Minimize and coordinate necessary outages with the Owner. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
4. Install new conduit and/or wiring as indicated to maintain existing operational characteristics or to provide new operational characteristics.
5. Demolish abandoned conduit and wiring as described above.
6. Remove temporary work upon completion of the permanent work.

B. Relocation of Electrical Equipment
1. This paragraph defines requirements for electrical remodeling where the existing equipment must be removed and re-installed in a new location and new conduit and conductors must be provided to reconnect the equipment.
2. Thoroughly investigate existing wiring and conduit to determine requirements for reconnection.
3. Provide temporary wiring and connections to maintain existing systems in service during construction. Minimize and coordinate necessary outages with the Owner. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
4. Remove equipment which is to be relocated.
5. Install equipment in designated new location.

6. Install new conduit and wiring as indicated to maintain existing operational characteristics or to provide new operational characteristics.
7. Demolish abandoned conduit and wiring as described above.
8. Remove temporary work upon completion of the permanent work.

3.07 CLEANING, PATCHING, AND REPAIR

A. Repair existing construction and finishes damaged during demolition and remodeling work. Refer to architectural specifications for patching requirements. Any damaged construction shall be repaired to match the finished, surrounding surfaces.

B. Clean and repair existing materials and equipment, which remain or are to be reused.

C. Clean exposed surfaces and check tightness of electrical connections.

D. Replace electrical equipment damaged during construction.

E. Remove construction debris from all electrical enclosures.

3.08 TESTING AND START-UP SERVICES (NOT USED)

3.09 TRAINING (NOT USED)

END OF SECTION

SECTION 26 05 02

UTILITY SERVICES

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs.

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards current edition:
    a. ANSI/NFPA 70 - National Electrical Code (NEC) and state amendments thereto
2. ASTM International (ASTM)
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. International Society of Automation (ISA)
6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition.
7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), Standard of Installation, Current Edition.
    a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
10. International Electrical Testing Association (NETA)
    a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
11. Canadian Standards Association (CSA), Specifications and Standards, current edition.
12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
13. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.

1.03 DESCRIPTION OF WORK

A. Provide and install complete and operable utility services as required on the drawings and as specified herein.

B. Payment of Electric Utility Company charges for service will be paid by an allowance of $3,000 which will be adjusted up or down by a change order to the Contract to reflect actual utility company invoices. Contractor handling charges, overhead, and mark-up shall be included in the base bid and are not included under this allowance.

C. Payment of Gas Utility Company charges for service will be covered by Utility as a new service.

D. Arrange with Electric Utility for permanent and temporary electric service.
   1. Electric Service:
      a. Utility Company: Madison Gas and Electric
         1) Contact: Tim Cole 608-252-4709
      b. b. System Characteristics:
         1) Facility type: Pump Station
         2) Required service voltage: 120/208V 3-phase, 4-wire.
         3) Required service size: 200A.

E. Arrange with gas utility for permanent and temporary natural gas service as specified herein.
   1. Natural Gas Service:
      a. Service Provider: Madison Gas and Electric
         1) Contact: Holly Powell 608-252-7214
      b. System Characteristics:
         1) Required Service Type: Standby Generator

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

F. Earthwork – Division 31

G. Utilities – Division 33

1.05 SUBMITTALS

A. Submit shop drawings.

B. The following information shall be submitted specifically for utility services:
   1. Manufacturer literature sufficient in scope to demonstrate compliance with the requirements of this specification.
      a. Clearly notate any exceptions taken to these specifications.
   2. Documentation required by utility company for approval.
   3. Failure to comply with these requirements does not relieve the Contractor of responsibility for meeting the project schedule.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NOT USED)

1.07 FACTORY TESTING (NOT USED)

1.08 QUALITY ASSURANCE

A. All work and materials shall conform to or exceed in every detail the applicable rules and requirements of the Wisconsin State Electrical Code Volumes 1 and 2, the National Electrical Code (ANSI/NFPA 70), other applicable National Fire Protection Association standards, the National Electrical Safety Code, and present manufacturing standards.

B. All work shall be performed under the direction of a State of Wisconsin Licensed Master Electrician.

C. Service entrance and metering equipment provided under this section shall be UL Listed for the service intended and shall be approved by the utility company.

D. All materials, equipment, and parts shall be new and unused of current manufacture.

E. Contractor shall be responsible for providing all necessary accessories required for a complete and operable system.

1.09 WARRANTY (NOT USED)

1.10 EXTRA MATERIALS (NOT USED)

1.11 DESIGN REQUIREMENTS (NOT USED)

1.12 MAINTENANCE

A. Before substantial completion, perform all maintenance activities required by any sections of the specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems into service.

B. Furnish all spare parts as required by other sections of the specifications.

PART 2 PRODUCTS AND MATERIALS (NOT USED)

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK

A. The Contractor shall be responsible for coordinating the division of work as it relates to Utility Services .

3.02 FIELD MEASUREMENTS

A. Field verify all measurements. Do not base electrical installation or equipment locations on the contract drawings. Actual field conditions govern all final installed locations, distances, and levels.

B. Verify that service equipment is ready to be connected and energized.

C. Make arrangements with utility company and obtain required inspections before energizing service(s).

D. Coordinate location of utility company facilities to ensure proper access is available.

3.03 DELIVERY, STORAGE, AND HANDLING (NOT USED)

3.04 INSTALLATION

A. Install service entrance conduit and conductors in accordance with utility company instructions.

B. Install metering equipment in accordance with utility company instructions.

3.05 TESTING AND START-UP SERVICES

A. Coordinate start-up and testing with utility company, and ensure proper inspections are completed prior to energizing service(s).

3.06 TRAINING (NOT USED)

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600V AND LESS)

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
    a. ANSI/NFPA 70 - National Electrical Code (NEC) and state amendments thereto.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
    a. ASTM B800-05 Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes-Annealed and Intermediate Tempers
    b. ASTM B801-99 Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
    a. NEMA WC 70/ICEA S-95-658-1999 – Standard for Non-shielded power cables rated 2000 volts or less for the distribution of electrical energy
    b. NEMA WC 57/ICEA S-73-532 – Standard for control, thermocouple extension, and instrumentation cables.
5. International Society of Automation (ISA)
6. National Electrical Manufacturers Association (NEMA)
7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
    a. U.L. 44 - Rubber-Insulated Wires and Cables.
    b. U.L. 50 - Enclosures for Electrical Equipment.
    c. U.L. 83 - Thermoplastic-Insulated Wires.
    d. U.L. 514B - Conduit, Tubing, and Cable Fittings.
    e. U.L. 758 - 105 degree C Appliance Wiring Materials.
    f. U.L. 854 - Service Entrance Cables.

g. U.L. 1063 - Machine-Tool Wires and Cables.
h. U.L. 1277 - Type TC Power and Control Tray Cables.
i. U.L. 1569 - Metal-Clad Cables.
j. U.L. 1581 - Vertical Tray.

8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), current edition.
   a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
10. International Electrical Testing Association (NETA)
    a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
11. Canadian Standards Association (CSA), Specifications and Standards, current edition.
12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
13. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.

1.03 DESCRIPTION OF WORK

A. Furnish and install complete and operable wire and cable systems as indicated on the drawings and as specified herein.

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

F. Earthwork – Division 31

G. Utilities – Division 33

1.05 SUBMITTALS

A. Submit shop drawings.

B. Review of shop drawings shall be for conformance with design concept only and will not release the Contractor for fulfilling the terms and intent of the contract documents.

C. The following information shall be submitted specifically for wire and cable:
1. Literature sufficient in scope to demonstrate compliance with the requirements of this specification.
2. Clearly identify the types, voltage class, and size of wire and cable proposed.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NOT USED)

1.07 FACTORY TESTING (NOT USED)

1.08 QUALITY ASSURANCE

A. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

B. Wire and cable manufacturers shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development and production in accordance with ISO 9001.

C. All materials, equipment, and parts shall be new and unused of current manufacture.

D. Contractor shall be responsible for providing all necessary accessories required for a complete and operable system.

1.09 WARRANTY (NOT USED)

1.10 EXTRA MATERIALS (NOT USED)

1.11 DESIGN REQUIREMENTS (NOT USED)

1.12 MAINTENANCE (NOT USED)

PART 2 PRODUCTS AND MATERIALS

2.01 WIRE AND CABLE - GENERAL PURPOSE (600V, COPPER)

A. Manufacturer: Contractor option.

B. General:
1. THWN/THHN general purpose building wire insulated with polyvinyl chloride (PVC) and covered with protective sheath of nylon intended for lighting and power circuits at 600 volts or less, in residential, commercial and industrial buildings.
2. The wire shall be suitable for 90 degree C maximum continuous conductor temperature in dry locations and 75 degree C in wet locations and listed by

Underwriters Laboratories for use in accordance with the National Electrical Code.

3. All wire for permanent installation shall be new stranded copper wire delivered to project in unopened cartons or reels, except where specifically noted and be UL listed for the use intended. No wire smaller than 12 AWG shall be used unless specifically noted. The use of multiconductore cable is NOT ALLOWED.

C. Conductors:
   1. Class B or Class C stranded, annealed uncoated copper per UL Standard 83 or 1063.

D. Insulation:
   1. Each conductor shall be insulated with PVC and sheathed with nylon complying with the requirements of UL Standard 83 for Types THHN/THWN and UL Standard 1063 for Type MTW and CSA C22.2 No. 75 for T90 Nylon.
   2. Types THWN/THHN shall comply with the optional Gasoline and Oil Resistant rating of UL Standard 83. The insulation shall also comply with UL requirements for 105 degree C Appliance Wiring Material.
   3. The average thickness of PVC insulation, for a given conductor size, shall be as specified in UL Standard 83 for Types THWN or THHN. The minimum thickness at any point, of the PVC insulation, shall be not less than 90 percent of the specified average thickness.
   4. The minimum thickness at any point of the nylon sheath shall be as specified in UL Standard 83 for Types THWN or THHN.
   5. The PVC insulation shall be applied tightly to the conductor and shall be free-stripping.

E. Identification:
   1. The wire shall be identified by surface marking indicating manufacturer's identification, conductor size and metal, voltage rating, UL Symbol, type designations and optional ratings. The wire shall also be identified as C(UL) Type T90 Nylon or TWN75, FT1.

F. Tests:
   1. Wire shall be tested in accordance with the requirements of UL Standard 83 for Types THWN or THHN wire and for the optional Gasoline and Oil Resistant listings; as Type MTW to UL Standard 1063 (stranded items); as AWM to UL Standard 758 (stranded items); and as C(UL) Type T90 Nylon or TWN75.

G. Usage:
   1. General use power wiring, minimum size No.12 AWG.

2. General use for field wiring associated with starter enclosures, control panels and supervisory control systems, minimum size No.14 AWG.
3. Control wiring within control panels and supervisory control stations shall be minimum size No. 18 AWG.
4. All connections and feeders to rotating and/or vibrating equipment.
5. All control wiring within starter enclosures, control panels, and supervisory control stations shall be 600-volt, insulation type THHN/THWN/TFFN or MTW. All field control wiring shall be 600-volt rated, insulation-type THHN/THWN.
6. Minimum size for field wiring associated with control panels and supervisory control stations shall be 14 AWG. Control wiring within control panels and supervisory control stations shall be minimum 18 AWG
7. Control wiring for supervisory equipment shall be shielded, sized per equipment manufacturer's recommendations, or as shown on drawings.

2.02 WIRE AND CABLE - GENERAL PURPOSE ~~(600V, ALUMINUM)~~

A. Manufacturer: Contractor option. (Follow schedule and provisions set on the plans.)

B. General:
1. XHHW-2 general purpose building wire insulated with cross linked polyethylene intended for service and feeder circuits at 600 volts or less, in residential, commercial and industrial buildings.
2. The wire shall be suitable for 90 degree C maximum continuous conductor temperature in wet or dry locations and listed by Underwriters Laboratories for use in accordance with the National Electrical Code.
3. All wire for permanent installation shall be new stranded copper wire delivered to project in unopened cartons or reels, except where specifically noted and be UL listed for the use intended. No wire smaller than 12 AWG shall be used unless specifically noted. The use of multiconductore cable is NOT ALLOWED.

C. Conductors:
1. Compact stranded aluminum AA-8000 series alloy conductors of a recognized Aluminum Association 8000 Series aluminum alloy per ASTM B800-05 and constructed in accordance with the specifications of ASTM B801-99.

D. Insulation:
1. Each conductor shall be insulated with cross linked polyethylene complying with the requirements of UL Standard 83 for Type XHHW-2.
2. Type XHHW-2 shall comply with the optional Gasoline and Oil Resistant rating of UL Standard 83.

3. The average thickness of cross linked polyethylene insulation, for a given conductor size, shall be as specified in UL Standard 83 for Types XHHW-2. The minimum thickness at any point shall be not less than 90 percent of the specified average thickness.

E. Identification:
1. The wire shall be identified by surface marking indicating manufacturer's identification, conductor size and metal, voltage rating, UL Symbol, type designations and optional ratings.

F. Tests:
1. Wire shall be tested in accordance with the requirements of UL Standard 83 for Types XHHW-2 wire and for the optional Gasoline and Oil Resistant listings.

G. Usage:
1. Service and feeder circuit wiring, minimum size No.2 AWG.
2. All connections and feeders to rotating and/or vibrating equipment.
3. Wiring for feeders and branch circuits 12 AWG and larger shall be 600 volt insulation type XHHW-2.

2.03 SHIELDED POWER CABLE (600V)

A. Manufacturer: Contractor option.

B. General:
1. Three conductor type TC Tray Cable insulated with cross linked polyethylene and PVC jacket overall, for use on circuits rated 600 volts and 90 degree C maximum continuous conductor temperature in wet or dry locations.
2. Cables approved for installation in cable trays in accordance with the NEC and for installation in air, in ducts or conduits, in tray or trough, in open wiring or direct buried.

C. Conductors:
1. Shall be Class B stranded uncoated soft copper.
2. Suitable separator over the conductor may be used at the option of the manufacturer.
3. Three phase conductors shall be cabled together with a Class B stranded, uncoated copper grounding conductor and suitable non-hygroscopic fillers to make round.
4. Length of lay shall not exceed 35 times the phase conductor diameter.
5. The grounding conductor shall comply with the requirements of UL Standard 1277.

6. The cable assembly shall be covered with a copper tape shield with drain wire, applied with a 10 percent minimum lap.

D. Insulation:
1. Each phase conductor shall be insulated with chemically cross linked polyethylene, meeting Type XHHW-2 requirements of Underwriters Laboratories.
2. The average thickness of insulation shall be as specified in UL Standard 44 for Type XHHW-2 conductors. The minimum thickness at any point shall be not less than 90 percent of the specified average thickness.
3. The insulated phase conductors shall be black in color and shall be printed with the numerals "1", "2", and "3" on their surface.
4. Each cable shall have a PVC protective jacket applied over the taped assembly. The jacket shall meet the Sunlight Resistant requirements of UL Standard 1277.
5. The average jacket thickness shall be in accordance with UL Standard 1277. The minimum thickness at any point shall be not less than 80 percent of the specified average thickness.

E. Identification:
1. Cables shall be identified by means of surface ink printing indicating manufacturer, number of conductors, size, voltage rating, and required UL information.

F. Tests:
1. Individual conductors and completed cables shall be tested in accordance with UL requirements for Type TC Power Control Tray Cables having XHHW-2 conductors.
2. Cables shall be capable of passing the ribbon burner cable tray flame test requirements of UL and IEEE.

G. Usage:
1. Power wiring for motor loads controlled by adjustable frequency drives, where so indicated on the drawings.

2.04 SHIELDED POWER CABLE - ARMORED (600V)

A. Manufacturer: Contractor option.

B. General:
1. Three conductor type TC Tray Cable insulated and armored, with cross linked polyethylene and PVC jacket overall, for use on circuits rated 600 volts and 90 degree C maximum continuous conductor temperature in wet or dry locations.

2. Cables approved for installation in cable trays in accordance with the NEC and for installation in air, in ducts or conduits, in tray or trough, in open wiring or direct buried.

C. Conductors:
1. Shall be Class B stranded uncoated soft copper.
2. Suitable separator over the conductor may be used at the option of the manufacturer.
3. Three phase conductors shall be cabled together with a Class B stranded, uncoated copper grounding conductor and suitable non-hygroscopic fillers to make round.
4. Length of lay shall not exceed 35 times the phase conductor diameter.
5. The grounding conductor shall comply with the requirements of UL Standard 1277.
6. The cable assembly shall be covered with a copper tape shield with drain wire, applied with a 10 percent minimum lap.

D. Insulation:
1. Each phase conductor shall be insulated with chemically cross linked polyethylene, meeting Type XHHW-2 requirements of Underwriters Laboratories.
2. The average thickness of insulation shall be as specified in UL Standard 44 for Type XHHW-2 conductors. The minimum thickness at any point shall be not less than 90 percent of the specified average thickness.
3. The insulated phase conductors shall be black in color and shall be printed with the numerals "1", "2", and "3" on their surface.
4. Each cable shall have a PVC protective jacket applied over the taped assembly. The jacket shall meet the Sunlight Resistant requirements of UL Standard 1277.
5. The average jacket thickness shall be in accordance with UL Standard 1277. The minimum thickness at any point shall be not less than 80 percent of the specified average thickness.

E. Armor:
1. Impervious, corrugated continuous seam-welded aluminum alloy sheath per UL 1569.
2. Armor shall be pressure tested and shall meet grounding requirements of NEC article 250.

F. Cable end fittings:
1. Manufacturer:
   a. Hubbell Killark Clencher 2000 MCR series.
   b. Or equal.
2. Fittings shall be designed for termination of continuously corrugated or interlocked armor type cables.

3. Fittings shall comply with the following:
    a. Heavy-duty nickel-plated brass construction.
    b. Moisture-sealing O-ring to prevent entry of moisture under cable armor.
    c. Cable jacket and O-ring seals.
    d. Stainless-steel compression spring for positive electrical connection and compliance with UL requirements.
4. Testing:
    a. Short-circuit testing shall comply with requirements of UL-514B.
    b. Corrosion testing shall comply with requirements of UL-50.

G. Identification:
1. Cables shall be identified by means of surface ink printing indicating manufacturer, number of conductors, size, voltage rating, and required UL information.

H. Tests:
1. Individual conductors and completed cables shall be tested in accordance with UL requirements for Type TC Power Control Tray Cables having XHHW-2 conductors.
2. Cables shall be capable of passing the ribbon burner cable tray flame test requirements of UL and IEEE.

I. Usage:
1. Power wiring for motor loads controlled by adjustable frequency drives, where so indicated on the drawings.

2.05 SHIELDED INSTRUMENTATION CABLE (300V)

A. Manufacturer: CONTRACTOR option.

B. General
1. Power limited tray cable - two conductor, No.16 AWG (7x24) bare copper, PVC insulation, overall shield with No.18 AWG (7x26) tinned copper drain wire, PVC jacket with nylon ripcord.
2. Power limited tray cable - three conductor, No.16 AWG (7x24) bare copper, PVC insulation, overall shield with No.18 AWG (7x26) tinned copper drain wire, PVC jacket with nylon ripcord.

C. Electrical Characteristics:
1. Max. Operating voltage: 300Vrms.
2. Conductor DC resistance at 20 deg. C: 3.7 Ohms/1000 ft.
3. Shield DC resistance at 20 degrees C: 5.1 Ohms/1000 ft.
4. Capacitance between conductors at 1 kHz: 61 pF/ft.
5. Capacitance between conductor and shield at 1 kHz: 114 pF/ft.

6. Inductance: 0.19 uH/ft.

D. Physical Characteristics:
1. Temperature rating: -30 to 105 degrees C.
2. Insulation material: PVC.
3. Average insulation thickness: 0.016-in.
4. Jacket material: Sun resistant PVC.
5. Jacket thickness: 0.037-in. nominal.
6. Shield: Aluminum/Polyester, 100 percent coverage.
7. Overall lay length: 2-in. (6 twists/ft).
8. Maximum pulling tension: 94 lbs.
9. Minimum bend radius: 2.6-in.
10. Flame resistance: UL 1581 vertical tray.

E. Usage:
1. Instrumentation cable.
2. Control wiring for supervisory equipment shall be shielded, sized per equipment manufacturer's recommendations, or as shown on drawings.

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK (NOT USED)

3.02 FIELD MEASUREMENTS

A. Field verify all measurements. Do not base electrical installation or equipment locations on the contract drawings. Actual field conditions govern all final installed locations, distances, and levels.

B. Identify conflicts with the work of other trades prior to installation of electrical system.

C. Adjust electrical system installation to satisfy field requirements.

3.03 DELIVERY, STORAGE, AND HANDLING

A. Accept electrical equipment on site. Inspect for damage.

B. Take precautions to protect electrical equipment from weather, corrosion, and entrance of debris.

3.04 INSTALLATION

A. Pre-Installation:
1. Verify that interior of building has been protected from weather.
2. Verify that mechanical work likely to damage wire has been completed.

3. Completely and thoroughly swab raceway prior to installation.
4. Verify that field measurements are as shown on drawings.
5. Wire and cable routing shown on drawings is approximate unless dimensioned. Route wire and cable to satisfy project conditions.
6. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.
7. Determine required separation between cable and other work.
8. Determine cable routing to avoid interference with other work.
9. Any single conduit or raceway utilized for a feeder circuit shall contain only power conductors of a single feeder circuit. Do not combine feeder circuits without engineer's written approval.
10. Contract drawings indicate individual homerun equipment connections. Contractor may combine branch circuits of common types in single conduits provided the following conditions are met:
    a. NEC requirements for conductor de-rating are satisfied.
    b. Conduit fill does not exceed thirty percent. Ten percent fill shall be reserved for future use.
11. No more than eight 24VDC analog circuits may be combined in a single conduit unless specifically stated otherwise on the drawings.

B. Conductor Sizing:
1. Conductor sizes are based on copper unless otherwise noted.
2. Use conductor not smaller than No.12 AWG for power and lighting circuits.
3. Use No.10 AWG conductors for 20 ampere, 120-volt branch circuits longer than 75 feet.
4. Where circuit wiring length exceeds length identified on the feeder schedule, increase wire size as needed to maintain a maximum voltage drop of three percent.
5. Use conductor not smaller than No.14 AWG for control circuits.
6. Unless shown otherwise on the contract drawings, power wiring shall be No.12 AWG.

C. Color-coding
1. See Section 26 05 53 – Identification for Electrical Systems for additional requirements.
2. All wire shall be color coded using electrical tape in sizes where colored insulation is not available. Where tape is used as the identification system, it shall be applied in all junction boxes, manholes and other accessible intermediate locations as well as at each termination.
3. The following color coding shall be used:

System	Wire	Color
240/120 Volts	Neutral	White
Single-Phase, 3 Wire	Line 1	Black
	Line 2	Red

208Y/120 Volts	Neutral	White
3-Phase, 4 Wire	Phase A	Black
	Phase B	Red
	Phase C	Blue
480Y/277 Volts	Neutral	Gray
3-Phase, 4 Wire	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow
120 Volt	Control	Red
24 Volt	Positive	Purple
	Common	Purple/White Stripe

D. Wire Pulling:
   1. Pull all conductors into raceway at same time.
   2. No.4 AWG and larger wire and power cables shall lubricated with UL approved pulling lubricant to reduce pulling tension and abrasion damage. The lubricant shall be water or wax based containing no oils or greases that may adversely affect cable jackets.
   3. The minimum bend radius and maximum pulling tension ratings of the wire and cable shall not be exceeded.

E. Splices and Terminations:
   1. Splices and terminations shall not be made within raceways.
   2. Clean conductor surfaces before splicing or terminating.
   3. Make splices, taps, and terminations to carry full amp capacity of conductors with no perceptible temperature rise.
   4. Insulated spring wire connectors may be used to splice 120V power circuits.
   5. Control, communication, and data transmission wire and cable shall not be spliced.
   6. Use split bolt connectors for copper conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.
   7. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
   8. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

F. Motors:
   1. Motor wiring to motors less than 10 horsepower shall be spliced and terminated with fully insulated crimp-on end cap with a layer of self-vulcanizing rubber tape, followed by five layers of vinyl electrical tape. “SkotchLocks” and similar devices shall not be used.
   2. Motor wiring to motors 10 horsepower or larger shall be spliced and terminated with crimp-on ring terminal lugs, brass nuts, bolts and washers

with a layer of self-vulcanizing rubber tape, followed by five layers of vinyl electrical tape. "SkotchLocks" and similar devices shall not be used.

G. Unshielded power cables:
1. Unshielded power cables shall be spliced and terminated with crimp-on ring terminal lugs, brass nuts, bolts and washers with a layer of self-vulcanizing rubber tape, followed by five layers of vinyl electrical tape. "SkotchLocks" and similar devices shall not be used.

H. Aluminum Conductor Connections:
1. Do not transition from copper to aluminum conductor when extending existing copper conductors.
2. Mechanical Screw Type Connectors:
   a. Connectors shall be dual rated (AL7CU or AL9CU) and Listed by UL for use with aluminum and copper conductors and sized to accept aluminum conductors of the ampacity specified.
   b. Using a suitable stripping tool, to avoid damage to the conductor, remove insulation from the required length of the conductor.
   c. Clean the conductor surface using a wire brush and apply a listed joint compound.
   d. Tighten the connection per the connector manufacturer's recommendation.
   e. Wipe off any excess joint compound.
3. Mechanical Compression Type Connectors:
   a. Connectors shall be dual rated (AL7CU or AL9CU) and Listed by UL for use with aluminum and copper conductors and sized to accept aluminum conductors of the ampacity specified.
   b. The lugs shall be marked with wire size, die index, number and location of crimps and shall be suitably color coded. Lug barrel shall be factory prefilled with a joint compound Listed by UL.
   c. Using a suitable stripping tool, to avoid damage to the conductor, remove insulation from the required length of the conductor.
   d. Clean conductor surface using a wire brush.
   e. Crimp the connection per the connector manufacturer's recommendation.
   f. Wipe off any excess joint compound.
4. Termination of Aluminum Conductor to Aluminum Bus:
   a. Prepare a mechanical screw or compression type connection.
   b. Hardware:
      1) Bolts: Anodized aluminum alloy 2024-T4 and conforming to ANSI B18.2.1 and to ASTM B211 or B221 chemical and mechanical property limits.
      2) Nuts: Aluminum alloys 6061-T6 or 6262-T9 and conforming to ANSI B18.2.2.

3) Washers: Flat aluminum alloy 2024-T4, Type A plain, standard wide series conforming to ANSI B27.2.

c. Lubricate and tighten the hardware as per the manufacturer's recommendations.

5. Termination of Aluminum Conductor to Copper Bus:
   a. Prepare a mechanical screw or compression type connection.
   b. Hardware:
      1) Bolts: Plated or galvanized medium carbon steel; heat treated, quenched and tempered equal to ASTM A-325 or SAE grade 5.
      2) Nuts: Heavy semi-finished hexagon, conforming to ANSI B18.2.2, threads to be unified coarse series (UNC), class 2B.
      3) Washers: Should be of steel, Type A plain standard wide series conforming to ANSI B27.2.
      4) Belleville conical spring washers: shall be of hardened steel, cadmium plated or silicone bronze.
   c. Lubricate and tighten the hardware as per the manufacturer's recommendations.
6. Termination of Aluminum Conductor to Equipment Not Equipped for Termination of Aluminum Conductor:
   a. Prepare compression connection using an adapter Listed by UL for the purpose or by pigtailing a short length of suitable size of copper conductor to the aluminum conductor with a compression connector Listed by UL.
   b. Provide an insulating cover over adapter body or the compression connector.
   c. Terminate the adapter or the pigtail on to the equipment per manufacturer's recommendation.

3.05 TESTING AND START-UP SERVICES

A. Inspect wire for physical damage and proper connection.

B. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.

C. Verify continuity of each conductor.

D. Feeder or branch circuits with ampacity greater than 100 amperes shall be tested after installation to measure insulation resistance of each conductor.

E. All equipment shall be disconnected and the wire ends shall be cleaned and dried.

F. Connect Megohmeter between conductor and a grounded point in the enclosure and energize until the reading stabilizes.

G. Perform an infrared survey of all aluminum conductor connections after the installation is complete and in normal service. Infrared surveys shall be performed with a minimum of 30 percent of rated full load. All connections with elevated temperatures shall be corrected by the contractor.

3.06 TRAINING (NOT USED)

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
    a. ANSI/NFPA 70 - National Electrical Code, (NEC) and state amendments thereto.
    b. ANSI/NFPA 99 - Health Care Facilities.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE), Specifications and Standards, current edition
    a. IEEE 837 – Standard for Qualifying Permanent Connections Used in Substation Grounding.
4. Insulated Cable Engineers Association (ICEA)
5. International Society of Automation (ISA)
6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, Current Edition
7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
    a. UL 467 – Ground and Bonding Equipment
8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), current edition.
    a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
10. International Electrical Testing Association (NETA)
    a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
11. Canadian Standards Association (CSA), Specifications and Standards, current edition.
12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
13. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.

1.03 DESCRIPTION OF WORK

A. Furnish and install complete and operable grounding and bonding systems as indicated on the drawings and as specified herein including but not limited to:
   1. Grounding electrodes.
   2. Bonding jumpers.
   3. Ground connections.

B. Provide bonding jumpers and wire, grounding bushings, clamps and appurtenances required for complete grounding system to bond equipment and raceways to equipment grounding conductors.

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

F. Earthwork – Division 31

G. Utilities – Division 33

1.05 SUBMITTALS

A. Submit shop drawings.

B. Review of shop drawings shall be for conformance with design concept only and will not release the Contractor for fulfilling the terms and intent of the contract documents.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NOT USED)

1.07 FACTORY TESTING (NOT USED)

1.08 QUALITY ASSURANCE

A. Measure ground resistance from system neutral connection at service entrance to convenient ground reference point using suitable ground testing equipment. Resistance shall not exceed 2 ohms. Additional grounding electrodes shall be used to satisfy ground resistance requirements where required by earth conditions.

B. All grounding components and materials shall be UL listed and labeled.

1.09 WARRANTY (NOT USED)

1.10 EXTRA MATERIALS (NOT USED)

1.11 DESIGN REQUIREMENTS (NOT USED)

1.12 MAINTENANCE

A. Before substantial completion, perform all maintenance activities required by any sections of the specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems into service.

PART 2 PRODUCTS AND MATERIALS

2.01 ROD ELECTRODE

A. Material: Copper-clad steel.

B. Diameter: 3/4-inch minimum.

C. Length: 10-feet minimum. Rod shall be driven at least 9.5-feet deep.

D. Use one or more ground rods to obtain the minimum specified ground resistance. This applies to manholes, padmount switches, transformers, service entrances, and all other equipment requiring a supplemental grounding electrode. Minimum of three ground rods shall be used to ground the service entrance as indicated on plans.

2.02 MECHANICAL CONNECTORS

A. The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made of silicon bronze and supplied as a part of the connector body and shall be of the two bolt type.

B. Split bolt connector types are not allowed.

C. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

2.03 COMPRESSION CONNECTORS

A. The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99 percent.

B. The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision.

C. The installation of the connectors shall be made with a compression, tool and die system, as recommended by the manufacturer of the connectors.

D. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compression tool settings.

E. Each connector shall be factory filled with an oxide-inhibiting compound.

F. Connector to be suitable for direct burial in earth and concrete.

2.04 EXOTHERMIC CONNECTIONS

A. Select the appropriate kit for specific types, sizes, and combinations of conductors and other items to be connected. Field personnel shall be trained in execution of welds.

2.05 WIRE

A. Material: Stranded copper (aluminum not permitted).

B. Grounding Electrode Conductor: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger.

C. Manhole and Vault Bonding: No. 4/0 minimum.

D. Feeder and Branch Circuit Equipment Ground: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger. Differentiate between the normal ground and the isolated ground when both are used on the same facility.

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK (NOT USED)

3.02 FIELD MEASUREMENTS

A. Field verify all measurements. Do not base electrical installation or equipment locations on the contract drawings. Actual field conditions govern all final installed locations, distances, and levels.

B. Identify conflicts with the work of other trades prior to installation of electrical system.

C. Adjust electrical system installation to satisfy field requirements.

3.03 DELIVERY, STORAGE, AND HANDLING (NOT USED)

3.04 INSTALLATION

A. General:
1. Verify that final backfill and compaction has been completed before driving rod electrodes.
2. Install products in accordance with manufacturer instructions.
3. Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.
4. Ground connection surfaces shall be cleaned and all connections shall be made so that it is impossible to move them.
5. Attach grounds permanently before permanent building service is energized.
6. Install rod electrodes at locations indicated or as required by local code, whichever requires the most rods. Install additional rod electrodes as required to achieve specified resistance to ground.
7. Connect grounding electrode conductor and reinforcing steel in foundation footing. Bond steel together.
8. Bond all conductive components to meet Regulatory Requirements.
9. Bond together metal siding not attached to grounded structure; bond to ground.
10. All separate ground wires shall be enclosed in rigid galvanized steel conduit and bonded at both ends to the rigid galvanized steel conduit with an approved fitting.
11. Provide a separate grounding conductor for each motor and connect at motor terminal box. Do not use bolts securing motor box to frame or cover for grounding conductors:
    a. When grounding motors driven by variable frequency drives (VFD) comply with the requirements of the VFD manufacturer.

B. Less than 600 volt system grounding:
1. Supplementary Grounding Electrode: Use driven ground rod on exterior of building.
2. Copper grounding electrode conductor shall be sized as indicated or as required by NEC, whichever is larger and shall be extended from secondary service system neutral to street side of water meter, building steel, ground rod, and any concrete encased electrodes. Bonding jumper shall be installed around water meter. Install conductor in separate rigid conduit. Bond conduit as described above.
3. Receptacle Grounding: All receptacles installed shall have a separate grounding contact.
4. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

5. Bond together each metallic raceway, pipe, duct and other metal objects.
6. Equipment Grounding Conductor: Separate, insulated green conductor shall be installed within each raceway and cable tray, sized per NEC or as indicated in the contract documents whichever is larger. Terminate each end on suitable lug, bus, enclosure or bushing, per NEC. Install a ground wire from each device to the respective enclosure.

3.05 TESTING AND START-UP SERVICES

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

3.06 TRAINING (NOT USED)

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American Iron and Steel Institute (AISI), Specifications and Standards, current edition.
2. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
    a. ANSI/NFPA 70 - National Electrical Code, (NEC) and state amendments thereto.
3. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
    a. ASTM A653 - General Requirements for Steel Sheet, Zinc-Coated Galvanized by the Hot-Dip Process.
    b. ASTM A1011 - Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Ally and High-Strength Low Alloy with Improved Formability (Formerly ASTM A570).
    c. ASTM F1136 - Standard Specification for Chromium/Zinc Corrosion Protective Coatings for Fasteners.
    d. ASTM A907 - Standard Specification for Steel, Sheet, and Strip, Heavy-Thickness Coils, Carbon, Hot-Rolled, Structural Quality.
    e. ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
    f. ASTM A 123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
    g. ASTM A 153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
    h. ASTM A 240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
4. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
5. Insulated Cable Engineers Association (ICEA)
6. International Society of Automation (ISA)
7. National Electrical Manufacturers Association (NEMA)

8. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
9. Wisconsin Department of Safety and Professional Services (DSPS)
10. National Electrical Contractors Association (NECA), current edition.
    a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
    b. NECA 101 - Standard for Installing Steel Conduit (Rigid, IMC, EMT).
11. Metal Framing Manufacturers Association (MFMA), Specifications and Standards, current edition.

1.03 DESCRIPTION OF WORK

A. Furnish and install supporting devices as indicated on the drawings, scheduled in Section 26 05 00, and as specified herein.

B. Demonstrate the following using generally accepted engineering methods:
1. That the anchors to the structure are adequate to resist the loads generated in accordance with the Building Code and equipment requirements.
2. That the required load capacity of the anchors can be fully developed in the structural materials to which they are attached.

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

F. Earthwork – Division 31

G. Utilities – Division 33

1.05 SUBMITTALS

A. Submit shop drawings.

B. Review of shop drawings shall be for conformance with design concept only and will not release the Contractor from fulfilling the terms and intent of the contract documents.

C. The following information shall be submitted specifically for supporting devices:
1. Submit outline drawings and dimensions for equipment support racks.

2. Include data on attachment hardware and construction methods that will satisfy the design loading and anchoring criteria.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NOT USED)

1.07 FACTORY TESTING (NOT USED)

1.08 QUALITY ASSURANCE

A. Bolted framing channels and fittings shall have the manufacturers' name, part number, and material heat code identification number stamped in the part itself for identification. Material certification sheets and test reports must be made available by the manufacturer upon request

B. Stainless steel bolted framing parts shall be stamped to identify the material. Material certification sheets and test reports must be made available by the manufacturer upon request.

C. All materials, equipment, and parts shall be new and unused of current manufacture.

D. Contractor shall be responsible for providing all necessary accessories required for a complete and operable system.

1.09 WARRANTY (NOT USED)

1.10 EXTRA MATERIALS (NOT USED)

1.11 DESIGN REQUIREMENTS (NOT USED)

1.12 MAINTENANCE (NOT USED)

PART 2 PRODUCTS AND MATERIALS

2.01 STRUT, CHANNELS, TRAPEZES AND CONNECTORS

A. Manufacturers:
1. Cooper B-Line, Inc.
2. or equal.

B. General:
1. Strut shall be 1-5/8-inches wide in varying heights and welded combinations as required to meet load capacities and designs indicated on the drawings.
2. Minimum sized threaded rod for supports shall be 3/8" for trapezes and single conduits 1-1/4" and larger, and ¼" for single conduits 1" and smaller.

C. Materials and Finish:

1. Hot-dip Galvanized Steel: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A907 SS, Grade 33, and hot-dip galvanized after fabrication in accordance with ASTM A123. All hardware shall be stainless steel Type 304 or chromium zinc ASTM F1136 Gr. 3. All hot-dip galvanized after fabrication products must be returned to point of manufacture after coating for inspection and removal of all sharp burrs.
2. Stainless Steel: All strut, fittings and hardware shall be made of AISI Type 304 stainless steel.

2.02 ANCHORS AND FASTENERS

A. Concrete and Structural Elements: Use stainless steel precast insert system, expansion anchors and preset inserts.

B. Steel Structural Elements: Use stainless steel beam clamps.

C. Concrete Surfaces: Use stainless steel self-drilling anchors and expansion anchors.

D. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts or hollow wall fasteners.

E. Solid Masonry Walls: Use stainless steel expansion anchors and preset inserts.

F. Sheet Metal: Use stainless steel sheet metal screws.

G. Wood: Use stainless steel wood screws.

H. All other fasteners: stainless steel screws, suitable for the required usage.

2.03 HARDWARE

A. Conduit and equipment supports, clamps, and other miscellaneous materials shall be constructed of the following materials as scheduled in Section 26 05 00.

1. Galvanized, malleable iron.
2. PVC coated, galvanized, malleable iron.
3. Stainless steel.
4. PVC.

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK

A. The Contractor shall be responsible for coordinating raceway installation and means of support with all applicable trades.

3.02 FIELD MEASUREMENTS

A. Field verify all measurements. Do not base locations and dimensions on the contract drawings. Actual field conditions govern all final installed locations, distances, and levels.

B. Identify conflicts with the work of other trades prior to installation of electrical equipment.

C. Adjust equipment support rack installation to satisfy field requirements.

3.03 DELIVERY, STORAGE, AND HANDLING

A. Accept supporting devices on site. Inspect for damage.

B. Protect supporting devices from corrosion and damage. Do not install damaged materials.

3.04 INSTALLATION

A. General:
   1. Furnish and install supports and fasteners for all electrical components required for the project, including free standing supports required for those items remotely mounted from the building structure, catwalks, walkways etc.
   2. Thoroughly clean and remove construction debris from installation.

B. Strut Channel:
   1. Install strut in accordance with MFMA-102 "Guidelines for the Use of Metal Framing"; in accordance with equipment manufacturer's recommendations, and with recognized industry practices.
   2. Fabricate supports from channel. Rigidly weld members or use hexagon head bolts to present a neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
   3. File and de-bur cut ends of galvanized support channel and spray paint with cold galvanized paint to prevent rusting.
   4. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

C. Anchors and Fasteners:

1. Provide anchors, fasteners, and supports in accordance with NECA "Standard Practices for Good Workmanship in Electrical Contracting".
2. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit.
3. Do not use spring steel clips and anchors.
4. Do not use powder-actuated anchors.
5. Obtain permission from Engineer before drilling or cutting structural members.
6. Install surface-mounted cabinets and panelboards with minimum of four anchors.
7. Use channel supports to stand cabinets and panelboards 1-5/8-inch off interior or exterior surfaces of exterior walls.
8. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using anchors and fasteners.
9. Install free-standing electrical equipment on 3-inch concrete pads unless indicated otherwise on the drawings.
10. Use threaded rod, minimum size 3/8-inch, for supports where indicated on the drawings.
11. Install products in accordance with manufacturer instructions.

3.05 TESTING AND START-UP SERVICES (NOT USED)

3.06 TRAINING (NOT USED)

END OF SECTION

SECTION 26 05 34

CONDUIT

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
    a. ANSI C80.1 - Electrical Rigid Steel Conduit (ERSC).
    b. ANSI C80.3 - Steel Electrical Metallic Tubing (EMT).
    c. ANSI C80.5 - Electrical Rigid Aluminum Conduit (ERAC).
    d. ANSI/NFPA 70 - National Electrical Code, (NEC) and state amendments thereto.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
    a. ASTM F2160 - Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter.
    b. ASTM D2239 - Polyethylene (PE) Plastic Pipe (SIDR) Based on Controlled Inside Diameter.
    c. ASTM D3035 - Polyethylene (PE) Plastic Pipe (SDR) Based on Controlled Outside Diameter.
    d. ASTM D3350 - Polyethylene Plastics Pipe and Fittings Materials.
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. International Society of Automation (ISA)
6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition:
    a. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association.
    b. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; National Electrical Manufacturers Association.
    c. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit; National Electrical Manufacturers Association.

d. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing; National Electrical Manufacturers Association.
e. NEMA TC 7 - Smooth Wall Coilable Polyethylene Electrical Plastic Conduit.

7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition:
   a. UL 1 - Standard for Flexible Metal Conduit
   b. UL 6 - Electrical Rigid Metal Conduit - Steel.
   c. UL 6A - Standard for Electrical Rigid Metal Conduit - Aluminum and Stainless Steel.
   d. UL 651A Type EB and A Rigid PVC Conduit and HDPE conduit.
   e. UL 651B Continuous Length HDPE.
   f. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit.
   g. UL 2239 - Standard for Safety for Hardware for the Support of Conduit, Tubing, and Cable.
8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), current edition.
   a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
   b. NECA 101 - Standard for Installing Steel Conduit (Rigid, IMC, EMT).
10. International Electrical Testing Association (NETA)
   a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
11. Canadian Standards Association (CSA), Specifications and Standards, current edition.
12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
13. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.

1.03 DESCRIPTION OF WORK

A. Furnish and install complete and operable conduit system as indicated on the drawings, scheduled in Section 26 05 00, and as specified herein.

B. Home runs indicated are to assist the Contractor in identifying conduits to be installed concealed or exposed. Conduits identified to be installed exposed shall be run near the ceilings or along the walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC ducts, cranes and hoists, lighting fixtures, doors, and hatches. Conduits indicated to be run concealed shall be run in the center of concrete floor slabs, in partitions, or above hung ceilings, as required.

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

F. Earthwork – Division 31

G. Utilities – Division 33

1.05 SUBMITTALS

A. Submit shop drawings.

B. Submit the following information specifically for conduit:
   1. Manufacturer literature sufficient in scope to demonstrate compliance with the requirements of this specification.
   2. Clearly identify the types and sizes of conduit and fittings proposed.
   3. Incorporate all changes in conduit routing on electrical plan drawings.
   4. Dimension underground and concealed conduit from building lines.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NOT USED)

1.07 FACTORY TESTING (NOT USED)

1.08 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.09 WARRANTY

A. See Division 01 for additional requirements.

1.10 EXTRA MATERIALS (NOT USED)

1.11 DESIGN REQUIREMENTS (NOT USED)

1.12 MAINTENANCE (NOT USED)

PART 2 PRODUCTS AND MATERIALS

2.01 GALVANIZED RIGID METAL CONDUIT (TYPE GRS)

A. Manufacturer: Contractor option.

B. Conduit:
1. Impact and crush resistant mild steel tube with an accurate circular cross section, a uniform wall thickness, a defect free interior surface, and a continuous welded seam.
2. Interior and exterior surfaces thoroughly and evenly coated with zinc using the hot-dip galvanizing process.
3. Top-coated with a compatible organic layer to inhibit white rust and increase corrosion resistance.
4. Factory cut threads, 0.75-inch taper per foot, protected after cutting with an application of molten zinc.

C. Conduit Bodies:
1. Ferrous metal construction electro-galvanized inside and out and coated with aluminum acrylic paint.
2. Tapered, threaded hubs with integral bushing.
3. Stainless steel hardware.
4. Cover constructed of same material with solid gasket.

D. Fittings:
1. Ferrous metal construction electro-galvanized inside and out.
2. Components critical to performance such as set screws, split rings, and locknuts constructed of hardened steel or adequately designed to insure positive bonds.

2.02 PVC COATED GALVANIZED RIGID METAL CONDUIT (TYPE PGRS)

A. Manufacturer:
1. Perma-Cote Industries.
2. Robroy.
3. Or equal.

B. General:

1. Conduit shall be UL Listed and the coating shall have been investigated by UL as providing the primary corrosion protection for the rigid metal conduit.
2. Independent certified test results shall be available to confirm coating adhesion under the following conditions:
3. Conduit immersed in boiling water with a minimum mean time to adhesion failure of 200 hours.
4. Conduit and condulet exposure to 150 degrees F and 95 percent relative humidity with a minimum mean time to failure of 30 days.
5. No trace of internal coating shall be visible on a white cloth following six wipes over the coating that has been wetted with acetone.
6. The exterior coating bond shall be confirmed using the methods described in Section 3.8, NEMA RN1. After these tests the physical properties of the exterior coating shall exceed the minimum requirements specified in Table 3.1, NEMA RN1.

C. Conduit:
1. Impact and crush resistant mild steel tube with an accurate circular cross section, a uniform wall thickness, and a defect free interior surface, and a continuous welded seam.
2. Interior and exterior surfaces thoroughly and evenly coated with zinc using the hot-dip galvanizing process.
3. Factory cut threads, 0.75-inch taper per foot, protected after cutting with an application of molten zinc.
4. Coating:
   a. External: PVC, 40 mils nominal, free of blisters, bubbles, and pinholes.
   b. Internal: Urethane, 2 mils minimum.
5. Threaded connections:
   a. Factory threads: factory coated.
   b. Field threads: protected by coating sleeve extension on female fitting. Sleeve extension shall be equivalent in length to the nominal conduit size and the inside diameter less than the outside diameter of the coated conduit.
6. Strength:
   a. Coating bond to conduit shall be stronger than tensile strength of coating. Field cut, thread, and bent conduit shall not damage conduit.

D. Conduit Bodies:
1. Ferrous metal construction electro-galvanized inside and out and PVC coated to match the conduit.
2. Tapered, threaded hubs with integral bushing.

3. Stainless steel or encapsulated stainless steel hardware.
4. PVC coated cover constructed of same material with solid tongue-in-groove gasket.

E. Fittings:
1. Ferrous metal construction electro-galvanized inside and out and PVC coated to match conduit.
2. All fittings are to be from the same manufacturer as the conduit.

2.03 RIGID NON-METALLIC CONDUIT (TYPE PVC)

A. Manufacturer:
1. Carlon.
2. Or equal.

B. Conduit:
1. Made from polyvinyl chloride compound (recognized by UL), which includes inert modifiers to improve weatherability and heat distortion.
2. Rated for use with 90 degree C conductors. Material shall comply with NEMA Specification TC-2.
3. The conduit and fittings shall be homogeneous plastic material free from visible cracks, holes or foreign inclusions. The conduit bore shall be smooth and free of blisters, nicks or other imperfections, which could mar conductors or cables.
4. Conduit, fittings and cement shall be produced by the same manufacturer to assure system integrity.
5. Schedule 80 non-metallic conduit shall be used in locations subject to physical damage.

C. Conduit Bodies:
1. Made from polyvinyl chloride compound (recognized by UL), which includes inert modifiers to improve weatherability and heat distortion.
2. Rated for use with 90 degree C conductors. Material shall comply with NEMA Specification TC-3.
3. Stainless steel hardware.
4. Cover constructed of same material with solid gasket.

D. Fittings:
1. Made from polyvinyl chloride compound (recognized by UL), which includes inert modifiers to improve weatherability and heat distortion.
2. Rated for use with 90 degree C conductors. Material shall comply with NEMA Specification TC-3.

2.04 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (TYPE LMFC)

A. Manufacturer: CONTRACTOR option.

B. Usage:
1. Use in conjunction with galvanized rigid metal conduit.
2. Use in conjunction with PVC coated galvanized rigid metal conduit.
3. Use in conjunction with rigid aluminum conduit.

C. Conduit:
1. Single strip, helically wound, galvanized steel core inside and outside with smooth interior surface with sunlight resistant thermoplastic jacket suitable for ambient environmental conditions conforming to applicable UL Standards.
2. Jacket shall be positively locked to core to prevent sleeving.
3. All runs of flexible conduit shall be as short as practicable, of the same size as the conduit it extends and with enough slack to reduce the effects of expansion and vibration.

D. Fittings:
1. Where used in conjunction with galvanized rigid metal conduit, connectors shall be malleable iron or steel, electro zinc plated, with insulated throat and taper threaded hub.
2. Where used in conjunction with PVC coated galvanized rigid metal or rigid aluminum conduit connectors shall be malleable iron or steel, electro zinc plated and PVC coated, with insulated throat and taper threaded hub.
3. Particular attention shall be given to maintaining ground bond and firm support through flexible connections.
4. All fittings shall be liquid tight.

2.05 LIQUIDTIGHT FLEXIBLE NON-METALLIC CONDUIT (TYPE LFNC)

A. Manufacturer:
1. Carlon Carflex.
2. Or equal.

B. Usage:
1. Use in conjunction with rigid nonmetallic PVC conduit.

C. Conduit:
1. Conduit shall have a smooth inner surface with integral reinforcement within the conduit wall.
2. Conduit shall be designated as a Type LFNC-B (or FNMC-B), listed to UL standard UL1660 and suitable for use at conduit temperatures of 80 degrees C (dry), 60 degrees C (wet and oil resistant).

3. Conduit shall be flame resistant and when used with listed fittings, approved for the installation of electrical conductors.
4. Conduit shall be installed in accordance with applicable sections of the NEC and/or local electrical codes.
5. Conduit shall be marked OUTDOOR for outdoor applications exposed to sunlight and weathering conditions and marked DIRECT BURIAL for direct burial applications.
6. The National Evaluation Service, Inc. shall evaluate conduit for installation within a three-hour or less fire-resistive floor/ceiling and two-hour fire-resistive wall construction.

D. Fittings:
1. Molded from high strength, chemical resistant, glass filled thermoplastic.
2. Fittings shall be listed for the use with liquid tight flexible nonmetallic conduit and shall be marked LFNC-B (FNMC-B).
3. Fittings uses for direct burial applications shall be listed for wet locations.
4. Particular attention shall be given to maintaining ground bond and firm support through flexible connections.
5. All fittings shall be liquid tight.

2.06 LIQUIDTIGHT HAZARDOUS LOCATION FLEXIBLE CONDUIT (STAINLESS STEEL BRAID)

A. Manufacturer:
1. Crouse-Hinds EC Coupling.
2. Or equal.

B. Usage:
1. Use for all non-intrinsically safe, hazardous location installations.
2. Use in hazardous locations for motor terminations and any other equipment where vibration is present.

C. Conduit:
1. Conduit shall have an insulating wire duct with smooth inner surface inside a flexible brass inner core. Packing material shall be woven cotton impregnated with asphalt.
2. Flexible portion of coupling shall be covered with stainless steel braid.
3. Conduit shall bear U.L. label indicating suitability for use in hazardous location as identified on the drawings.

D. Fittings:
1. Integral stainless steel end fittings shall be included with coupling.
2. Coupling shall be available with two threaded male end fittings or one female union and one threaded male end fitting.

3. Particular attention shall be given to maintaining ground bond and firm support through flexible connections.
4. All fittings shall be liquid tight.

2.07 RIGID ALUMINUM CONDUIT (TYPE RAL)

A. Manufacturer: Contractor option.

B. Conduit:
1. Heavy wall tube manufactured of 6063 aluminum allow in temper designation T-1 with accurate circular cross section, uniform wall thickness and defect free interior surface.
2. Factory cut threads, 0.75-inch taper per foot.

C. Conduit Bodies:
1. Cast aluminum device boxes shall by Type FD. Boxes shall be copper free aluminum with cast aluminum covers.
2. Tapered, threaded hubs with integral bushing.
3. Stainless steel hardware.

D. Fittings:
1. Fittings shall be composed of copper free aluminum.

2.08 HIGH DENSITY POLYETHYLENE CONDUIT (TYPE HDPE)

A. Manufacturer:
1. Contractor Option

B. Usage:
1. Direct buried for use in routing Fiber Optic Cable.

C. Conduit:
1. Smooth wall construction
2. Comprised of high-density polyethylene meeting the properties of ASTM D-3350.
3. Conduit shall meet the dimensional specifications and wall thicknesses set forth in the applicable ASTM and/or NEMA standards.
4. There shall be no foreign particles embedded into the plastic surface as a result of the extrusion process.
5. There shall not be any holes, visible cracks or defects that could cause damage or compromise the physical strength of the conduit.

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK

A. The Contractor shall be responsible for coordinating raceway installation and means of support with all applicable trades.

3.02 FIELD MEASUREMENTS

A. The Contractor shall obtain from the appropriate trades and review shop drawings for all equipment requiring electrical connections. Conduit rough-in shall be based upon shop drawing requirements.

B. The Contractor shall be responsible for coordinating conduit location and rough-in with actual equipment conditions and requirements.

C. Field verify all measurements. Do not base conduit rough-in or equipment locations on the contract drawings. Actual field conditions govern all final installed locations, distances, and levels.

D. Identify conflicts with the work of other trades prior to installation of electrical equipment and conduit work.

E. Adjust conduit system installation to satisfy field requirements.

3.03 DELIVERY, STORAGE, AND HANDLING

A. Accept conduit on site. Inspect for damage.

B. Protect conduit from corrosion and entrance of debris.

C. Store conduit above grade. Protect from environment with suitable covering.

D. Protect PVC and PVC coated conduit from sunlight.

3.04 INSTALLATION

A. General:
   1. Install conduit in accordance with NECA "Standard Practices for Good Workmanship in Electrical Contracting", all requirements of the NEC, and manufacturer recommended practices.
   2. Arrange conduit to maintain headroom and present neat appearance.
   3. Design raceway systems to minimize the number of fittings, couplings, kicks, and offsets.
   4. Raceways located above lowest floor level:
      a. Route conduit parallel and perpendicular to walls.
      b. All raceways shall be level and straight.
      c. Vertical conduits shall be plumb.
   5. Raceways located in or under lowest level floor:

a. Route conduit in and under slab from point-to-point.
b. Do not cross conduits in slab.

6. Do not use flexible conduit in place of bends, conduit bodies, or expansion fittings.
7. Flexible conduit shall be used at all equipment terminations. Maximum length of 24-inches unless specifically allowed otherwise by Engineer based upon field conditions.
8. Do not use cords for equipment connections unless specifically allowed otherwise by Engineer based upon field conditions.

B. Raceway sizing:

1. Size raceways as indicated on drawings.
2. Where raceways sizes are not indicated on drawings, size in accordance with NEC requirements. Minimum size 3/4-inch.
3. Exposed conduit runs not longer than 10-feet in length and terminating at a single device may be 1/2-inch unless prohibited by NEC.

C. Raceway Installation:

1. Maintain adequate clearance between conduit and piping.
2. Maintain 12-inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F.
3. Cut conduit square using saw or pipe cutter; de-burr cut ends.
4. Bring conduit to shoulder of fittings; fasten securely.
5. Use conduit hubs to fasten conduit to NEMA 3R, NEMA 4, NEMA 4X and NEMA 12 boxes.
6. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic factory elbows for bends in metal conduit larger than 2-inch size.
7. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
8. Suitable pull string shall be installed in each empty conduit, sleeves and nipples excepted.
9. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
10. Remove all debris and moisture from raceways prior to installing conductors.
11. Ground and bond conduit under provisions of Section 26 05 26.
12. Identify conduit under provisions of Section 26 05 53.
13. Install plastic coated conduit in accordance with manufacturer's instructions. All 90 degree bends shall be manufactured elbows. Touch-up PVC coating after installation.

14. All field cut threads shall be coated with Thomas & Betts Kopr-Shield prior to assembly.
15. The contractor is responsible for any deviations in general location, conduit size, routing, or changes to the conduit schedule without the express written approval or direction by the Engineer.

D. Structural Coordination:
1. Suitable fittings, designed and listed for the purpose, shall be used to accommodate expansion and deflection where conduit crosses seismic, control and expansion joints.
2. Install conduit to preserve fire resistance rating of partitions and other elements.
3. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation.
4. Where conduit passes between areas subject to variable temperatures, seal conduits to prevent air interchange and condensation formation. Use conduit fitting specifically manufactured for this purpose.

E. Raceway Support:
1. General:
a. Arrange supports to prevent misalignment during wiring installation.
b. Do not permanently support conduit with wire or perforated pipe straps.
c. Remove wire used for temporary supports.
d. Do not attach conduit to ceiling support wires.
e. Channel, rod, and hardware shall comply with the requirements of Section 26 05 29.
2. Hardware:
a. Construct conduit support rack with channel and rod to support conduits not supported from structure.
b. Support conduit with channel anchored to structure when conduit offset from structure is required.
c. Secure conduits to channel with pipe straps.
d. Support conduit from structure when conduit offset from structure is not required.
e. Secure conduits directly to structure with one-hole strap and conduit spacer.

F. Conduit Separation:
1. Separate conduit systems shall be used for the following circuit categories:
a. 120-volt power circuits.
b. 480-volt power circuits.

c. 120-volt control circuits.
d. 24 VDC analog control circuits.
e. Intrinsically safe control circuits.
f. UTP control cables.
g. Manufacturer supplied cables (for example, magnetic flow meter cables).
h. Radio frequency coaxial cables (for example, antenna cables).

2. The contract drawings show individual homerun equipment connections. The Contractor may combine circuits of common types (as identified above) into single conduits provided the following conditions are met:
   a. NEC requirements for conductor de-rating are satisfied.
   b. Conduit fill does not exceed thirty percent. Ten percent fill shall be reserved for future use.
   c. No more than eight 24VDC analog circuits are combined in a single conduit, unless specifically stated otherwise on the drawings.

3.05 TESTING AND START-UP SERVICES (NOT USED)

3.06 TRAINING (NOT USED)

END OF SECTION

SECTION 26 05 37

BOXES

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
    a. ANSI/NFPA 70 - National Electrical Code, (NEC) and state amendments thereto.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition.
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. International Society of Automation (ISA)
6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition.
    a. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical Manufacturers Association.
    b. ANSI/NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
    c. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), current edition.
    a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
    b. NECA 101 - Standard for Installing Steel Conduit (Rigid, IMC, EMT).
10. International Electrical Testing Association (NETA)
    a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

11. Canadian Standards Association (CSA), Specifications and Standards, current edition.
12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
13. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.

1.03 DESCRIPTION OF WORK

A. Furnish and install complete and operable box systems as indicated on the drawings, scheduled in Section 26 05 00, and as specified herein.

B. This includes outlet boxes for devices such as switches, receptacles, telephone and computer jacks, security systems, junction and pullboxes for use in the raceway system, etc.

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

F. Earthwork – Division 31

G. Utilities – Division 33

1.05 SUBMITTALS

A. Submit shop drawings.

B. Review of shop drawings shall be for conformance with design concept only and will not release the Contractor from fulfilling the terms and intent of the contract documents.

C. Submit the following information specifically for boxes:
1. Manufacturer literature sufficient in scope to demonstrate compliance with the requirements of this specification.
2. Clearly identify the size and types of boxes proposed. Also include the materials of construction, conduit entry locations and NEMA rating of the proposed.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NOT USED)

1.07 FACTORY TESTING (NOT USED)

1.08 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.09 WARRANTY (NOT USED)

1.10 EXTRA MATERIALS (NOT USED)

1.11 DESIGN REQUIREMENTS (NOT USED)

1.12 MAINTENANCE (NOT USED)

PART 2 PRODUCTS AND MATERIALS

2.01 OUTLET BOXES

A. Sheet Metal Outlet Boxes:
1. Galvanized steel, with stamped knockouts.
2. Gangable, suitable for number of devices shown.
3. Suitable for flush mounting with drywall, FRP panel, masonry block, and poured concrete wall and ceiling finishes.

B. Luminaire and Equipment Supporting Boxes:
1. Rated for weight of equipment supported; include 3/8-inch male fixture studs where required.

C. Cast Boxes:
1. Cast ferralloy or aluminum, deep type, gasketed cover, threaded hubs.
2. Suitable for surface or flush mounting with drywall, FRP panel, masonry block, and poured concrete wall and ceiling finishes.

D. PVC Coated Cast Boxes:
1. PVC coated cast ferralloy, deep type, gasketed cover, threaded hubs.

2. Suitable for surface mounting with drywall, FRP panel, masonry block, and poured concrete wall and ceiling finishes.
3. Of the same manufacturer as the associated PVC coated conduit.

2.02 PULL AND JUNCTION BOXES

A. General:
1. Pull boxes and junction boxes shall be minimum 4 inch square (100 mm) by 2 1/8th inches (54 mm) deep for use with 1 inch (25 mm) conduit and smaller. On conduit systems using 1 1/4 inch (31.75 mm) conduit or larger, pull and junction boxes shall be sized per NEC but not less than 4 11/16 inch square (117 mm).
2. For telecommunication, fiber optic, security, and other low voltage cable installations the NEC box size requirements shall apply. All boxes, used on telecommunication, security, other low voltage and fiber optic systems with conduits of 1 1/4" and larger, shall be sized per the NEC conduit requirements. For determining box size, the conduit is the determining factor not the wire size.

B. Galvanized Sheet Metal Boxes: code gauge galvanized steel, screw covers, flanged and spot welded joints and corners.
1. Door:
   a. Rolled lip around 3 sides
   b. Attached to enclosure by means of a continuous stainless steel hinge and pin.
2. Neoprene door gasket to provide a watertight, dust tight, oil tight seal.
   a. Attached with an adhesive.
3. Fabricate all external removable hardware for clamping the door to the enclosure body from zinc-plated heavy gauge steel.
   a. With a hasp and staple for padlocking

C. Painted Sheet Metal Boxes: code gauge sheet steel with ANSI-61 gray powder-coated finish, flanged and spot welded joints and corners.
1. Door:
   a. Rolled lip around 3 sides
   b. Attached to enclosure by means of a continuous stainless steel hinge and pin.
2. Neoprene door gasket to provide a watertight, dust tight, oil tight seal.
   a. Attached with an adhesive.
3. Fabricate all external removable hardware for clamping the door to the enclosure body from zinc-plated heavy gauge steel.
   a. With a hasp and staple for padlocking

D. Fiberglass Reinforced Plastic Boxes: fiberglass reinforced plastic construction with stainless steel hardware and gasketed covers. Boxes shall be finished with

hinged doors, terminal mounting straps and brackets. Box shall hold NEMA 4X environmental rating.

E. Boxes Larger than 12 Inches (300 mm) in any dimension shall have a hinged cover, be rated NEMA 4X, and constructed of stainless steel. Door and body stiffeners to be provided as required for extra rigidity on larger enclosure.
   1. Fabricated from grade 316 stainless steel
   2. Door:
      a. Rolled lip around 3 sides
      b. Attached to enclosure by means of a continuous stainless steel hinge and pin.
   3. Neoprene door gasket to provide a watertight, dust tight, oil tight seal.
      a. Attached with an adhesive.
   4. Fabricate all external removable hardware for clamping the door to the enclosure body from heavy gauge stainless steel.
      a. With a hasp and staple for padlocking

F. Cast Metal Boxes for Outdoor and Wet Location Installations: Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as rain-tight. Galvanized cast iron or aluminum box and cover with ground flange, neoprene gasket, and stainless steel cover screws.

G. Cast Metal Boxes for Hazardous Locations: Type 7, cast malleable iron with drilled and tapped conduit entrance. Cast malleable iron cover, non-hinged with Type 316 stainless steel screws and gasketed.

H. Cast Metal Boxes for Underground Installations: Type 4, inside flanged, recessed cover box for flush mounting, UL listed as rain tight. Hot dipped galvanized cast iron box and plain cover with neoprene gasket and stainless steel cover screws. Cover Legend: ELECTRIC.

I. Fiberglass Handholes for Underground Installations: Die- molded with pre-cut 6 x 6 inch (150 x 150 mm) cable entrance at center bottom of each side; fiberglass weatherproof cover with non-skid finish.

J. Box extensions and adjacent boxes within 48” of each other are not allowed for the purpose of creating more capacity.

K. Junction boxes 6" x 6" or larger size shall be without stamped knock-outs.

L. Wireways shall not be used in lieu of junction boxes.

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK (NOT USED)

3.02 FIELD MEASUREMENTS

A. The Contractor shall obtain from the appropriate trades and review shop drawings for all equipment requiring electrical connections. Box rough-in shall be based upon shop drawing requirements.

B. The Contractor shall be responsible for coordinating box location and rough-in with actual equipment conditions and requirements.

C. Field verify all measurements. Do not base box rough-in or equipment locations on the contract drawings. Actual field conditions govern all final installed locations, distances, and levels.

D. Identify conflicts with the work of other trades prior to installation of electrical equipment and conduit work.

E. Adjust box locations to satisfy field requirements.

3.03 DELIVERY, STORAGE, AND HANDLING

A. Accept boxes on site. Inspect for damage.

B. Protect boxes from corrosion and entrance of debris.

C. Store boxes above grade. Protect from environment with suitable covering.

3.04 INSTALLATION

A. General:
   1. Install conduit in accordance with NECA "Standard Practices for Good Workmanship in Electrical Contracting", all requirements of the NEC, and manufacturer recommended practices.

B. Box Installation:
   1. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
   2. Install electrical boxes to maintain headroom and to present neat mechanical appearance.
   3. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
   4. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.
   5. Use flush mounting outlet boxes in all areas.

6. Do not install flush mounting boxes back-to-back in walls; provide minimum 6-inch separation. Provide minimum 24-inches separation in acoustic rated walls.
7. Use gang box where more than one device is mounted together. Do not use sectional box.
8. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose. Include installation within 10 feet of location shown.
9. Position outlet boxes to locate luminaires as shown on lighting plans.
10. Adjust flush-mounting outlets to make front flush with finished wall material.
11. Install knockout closure in unused box opening.

C. Structural Coordination:
1. Install boxes to preserve fire resistance rating of partitions and other elements.
2. Install flush mounting box without damaging wall insulation vapor barrier or reducing its effectiveness. Provide vapor box or vapor barrier hat for each box flush mounted in an exterior wall.
3. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
4. Coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes.

D. Box Support:
1. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
2. Use stamped steel bridges to fasten flush mounting outlet box between studs.
3. Use adjustable stainless steel channel fasteners for hung ceiling outlet box.
4. Do not fasten boxes to ceiling support wires.
5. Support boxes independently of conduit.

3.05 TESTING AND START-UP SERVICES (NOT USED)

3.06 TRAINING (NOT USED)

END OF SECTION

SECTION 26 05 41

WIRING DEVICES

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
    a. ANSI/NFPA70 - National Electrical Code, (NEC) and state amendments thereto.
    b. ANSI/NFPA 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. International Society of Automation (ISA)
6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition.
    a. NEMA WD 1 - General Purpose Wiring Devices.
    b. NEMA WD 6 - Wiring Device Configurations.
7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), Standard of Installation, current edition.
10. International Electrical Testing Association (NETA)
    a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
11. Canadian Standards Association (CSA), Specifications and Standards, current edition.
12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
13. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.

1.03 DESCRIPTION OF WORK

A. Provide and install complete and operable wiring devices as required on the drawings and as specified herein.

1.04 RELATED WORK ELSEWHERE

A. The following divisions may include work which is related to wiring devices, but which is not included under the scope of this section:

B. Article 102 – Bidding Requirements and Conditions

C. Article 103 – Award and Execution of the Contract

D. Concrete – Division 03

E. Metals – Division 05

F. Electrical - Division 26

G. Earthwork – Division 31

H. Utilities – Division 33

1.05 SUBMITTALS

A. Submit shop drawings.

B. Review of shop drawings shall be for conformance with design concept only and will not release the Contractor from fulfilling the terms and intent of the contract documents.

C. The following information shall be submitted specifically for wiring devices:
   1. Manufacturer literature sufficient in scope to demonstrate compliance with the requirements of this specification.
   2. Clearly identify the types of wiring devices proposed.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NOT USED)

1.07 FACTORY TESTING (NOT USED)

1.08 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. Contractor shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

D. Manufacturer shall specialize in manufacture of products specified in this Section with minimum three years experience.

1.09 WARRANTY (NOT USED)

1.10 EXTRA MATERIALS (NOT USED)

1.11 DESIGN REQUIREMENTS (NOT USED)

1.12 MAINTENANCE

A. Before substantial completion, perform all maintenance activities required by any sections of the specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems into service.

B. Furnish all spare parts as required by other sections of the specifications.

PART 2 PRODUCTS AND MATERIALS

2.01 120V SPECIFICATION GRADE WALL SWITCHES

A. Single Pole Switch:
1. Hubbell.
2. Or equal.

B. Double Pole Switch:
1. Hubbell.
2. Or equal.

C. Three-way Switch:
1. Hubbell.
2. Or equal.

D. Four-way Switch:
1. Hubbell.
2. Or equal.

E. Indicator Switch:
1. Hubbell.
2. Or equal.

F. Weather-proof Switch:
1. Hubbell.
2. Or equal.

G. Explosion Proof Switch:
1. Appleton.
2. Crouse-Hinds.
3. Or equal.

2.02 120V SPECIFICATION GRADE RECEPTACLES

A. Duplex Convenience Receptacle:
1. Hubbell.
2. Or equal.

B. GFCI Receptacle:
1. Hubbell.
2. Or equal.

2.03 USB CHARGING STATION

A. Single-gang 4-port USB Charging Station
1. Hubbell.
2. Or equal.

2.04 OCCUPANCY SENSORS

A. Wall Mounted
1. WattStopper
2. Or equal.

B. Ceiling Mounted
1. WattStopper
2. Or equal.

C.

2.05 WALL PLATES

A. Wall plates shall be installed as follows:
1. Use smooth stainless steel plates for receptacles and switches in sheet steel or PVC boxes.
2. Use multi-screw gasketed cast plate where cast outlet boxes are required. Covers shall not be attached by using a single screw mounting into the wiring device, but shall be attached by mounting directly to the box.

3. Use Crouse Hinds WLRS or WLRD wet location covers for receptacles identified as “WP” which are located inside structures.
4. Use aluminum or cast metal cover rated for “Constant Use” for receptacles identified as “WP” and that are exposed to the weather.
5. Use Crouse-Hinds OS185 cover for all switches identified as “WP”.

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK

A. The Contractor shall have overall system responsibility and shall provide all materials and labor necessary provide a complete and operable system and comply with all requirements of this section.

B. The Contractor shall be responsible for coordinating device locations with actual equipment conditions and requirements.

3.02 FIELD MEASUREMENTS

A. Field verify all measurements. Do not base exact wiring device locations on the contract drawings. Actual field conditions govern all final installed locations, distances, and levels.

B. Adjust location of wiring devices to satisfy field requirements.

3.03 DELIVERY, STORAGE AND HANDLING

A. Accept electrical equipment on site. Inspect for damage.

B. Take precautions to protect electrical equipment from weather, corrosion, and entrance of debris.

3.04 INSTALLATION

A. Wiring Device Installation:
1. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
2. Provide extension rings to bring outlet boxes flush with finished surface.
3. Clean debris from outlet boxes.
4. Install products in accordance with manufacturer's instructions.
5. Install devices plumb and level.
6. Install switches with OFF position down.
7. Install receptacles with grounding pole on top.
8. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
9. Install plates on switch, receptacle, and blank outlets in all areas.

10. Connect wiring devices by wrapping conductor around screw terminal.
11. Provide stainless steel hardware.
12. Install wall switch 46 inches above finished floor.
13. Install convenience receptacle 18 inches above finished floor.
14. Install convenience receptacle 6 inches above counter.
15. Adjust devices and wall plates to be flush and level.

B. Structural Coordination:
1. Verify outlet boxes are installed at proper height.
2. Verify wall openings are neatly cut and will be completely covered by wall plates.
3. Verify floor boxes are adjusted properly.

3.05 TESTING AND STARTUP SERVICES

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

3.06 TRAINING (NOT USED)

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
    a. ANSI/NFPA 70 - National Electrical Code, (NEC) and state amendments thereto.
    b. ANSI Z535.4 - Product Safety Signs and Labels.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. International Society of Automation (ISA)
6. National Electrical Manufacturers Association (NEMA)
7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), current edition.
    a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
10. International Electrical Testing Association (NETA)
    a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
11. Canadian Standards Association (CSA), Specifications and Standards, current edition.
12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
13. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.

1.03 DESCRIPTION OF WORK

A. Furnish and install electrical identification systems as indicated on the drawings and as specified herein.

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

F. Earthwork – Division 31

G. Utilities – Division 33

1.05 SUBMITTALS

A. Submit shop drawings.

B. Submit literature sufficient in scope to demonstrate compliance with the requirements of this specification.
   1. Nameplates:
      a. Color
      b. Size
         1) Outside dimensions
         2) Lettering
      c. Material
      d. Mounting means
   2. Nameplate Schedule
      a. Show exact wording for each nameplate.
      b. Include nameplate and letter sizes.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NOT USED)

1.07 FACTORY TESTING (NOT USED)

1.08 QUALITY ASSURANCE (NOT USED)

1.09 WARRANTY (NOT USED)

1.10 EXTRA MATERIALS (NOT USED)

1.11 DESIGN REQUIREMENTS (NOT USED)

1.12 MAINTENANCE (NOT USED)

PART 2 PRODUCTS AND MATERIALS

2.01 NAMEPLATES

A. Engraved three-layer laminated plastic, black letters on white background.

B. Lettering:
1. 1/4-inch letters for identifying individual equipment and loads.
2. 1/2-inch letters for identifying grouped equipment and loads.

C. Control panel nameplates to be attached with two stainless steel screws.

D. Where mounting screws would de-rate an enclosure, UV resistant adhesive is permissible.

2.02 CONDUCTOR MARKING

A. The ends of each conductor shall be marked with circuit number, motor number, wire or terminal number.

B. Control system wire marking shall be coordinated with control system and equipment shop drawings.

C. Labels shall be typed in black lettering with indelible ribbons on a white, heat shrink sleeve. Markers shall be shrunk around the wire to ensure a tight, non-slip bond with a compatible heat gun.

D. Heat shrink wire markers shall be Brady Bradysleeve Type B-321 or B-322.

2.03 CONDUCTOR COLOR CODING

A. Conductors No.6 AWG and smaller shall be provided with color coded insulation as described herein. Conductors larger than No.6 AWG may be color coded with appropriately colored Scotch No.35 tape at each end.

B. Color Coding:
1. 277/480 vac system shall be colored brown, orange, yellow, and gray for phases A, B, C, and neutral respectively.
2. 120/208 vac system shall be colored black, red, blue, and white for phases A, B, C, and neutral respectively.

3. 120/240 vac shall be colored black, red, and white for Line 1, Line 2, and neutral respectively.
4. 120 vac control wiring shall be colored red.
5. 24 VDC control wiring shall be colored ~~purple~~blue and ~~purple~~blue with white stripe for positive and negative conductors respectively.
6. Intrinsically safe control wiring shall be colored light blue.
7. Conductors within control cabinets and motor control centers carrying voltage supplied from an external source shall be colored yellow.
8. Grounding conductor and equipment ground conductors shall be colored green.

2.04 CONDUIT MARKING

A. Colored band markers shall be field painted.

B. Color:
1. 480 Volt System: Yellow.
2. 208 Volt and 240 Volt System: White.
3. Fire Alarm System: Red.
4. Low Voltage Communication System: Black.
5. Process Instrumentation and Control System: Blue.

2.05 EQUIPMENT, ENCLOSURE, AND CABINET WARNING SIGNS

A. Electrical Voltage and Shock Hazard Signs
1. Provide OSHA Voltage and Shock Hazard sign for each electrical enclosure, cabinet, or other piece of equipment that presents an electrical hazard under normal operating circumstances or presents an electrical hazard while the enclosure is open.

B. Electrical Arc Flash Hazard Signs
1. Provide Arc Flash Hazard sign for each electrical enclosure, cabinet, or other piece of equipment that presents an arc flash hazard in accordance with NEC and ANSI Z535.4.

C. Electrical Source Signs
1. Provide sign indicating voltage level and source for each component of the power distribution system and for all control panels.
2. Provide indicating multiple sources where equipment is fed from multiple sources or where signal wiring is present that is powered from a source external to the equipment

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK (NOT USED)

3.02 FIELD MEASUREMENTS (NOT USED)

3.03 DELIVERY, STORAGE, AND HANDLING (NOT USED)

3.04 INSTALLATION

A. Nameplates:
1. Provide nameplates for grouped equipment such as panelboards, transformers, motor control centers, and control panels. Nameplate shall identify tag number, voltage, ampere rating, and description.
2. Provide nameplates for individual equipment such as motor control center compartments, field instruments, and field control stations. Nameplate shall identify tag number and description.
3. Provide nameplates for individual receptacles. Nameplate shall identify panel and circuit number supplying the receptacle.
4. Provide nameplates for control cabinets and motor control center compartments which contain wiring supplied from an external source. Nameplate shall state: Multiple power sources within, verify all power supplies are disconnected before servicing equipment.
5. Nameplates shall be secured to the front of equipment enclosures with stainless steel screws or rivets, or epoxy-based cement. Double sided tape will not be acceptable.
6. Secure nameplates for flush mounted panelboards behind the panelboard door.
7. Nameplates shall be aligned and level or plumb. Misaligned or crooked nameplates shall be remounted, or provide new enclosures at the discretion of the Engineer.

B. Conductor Marking:
1. Mark conductors at every termination and splice point.
2. Mark conductors with wire numbers identified by control system supplier, with panel and circuit identification, or with MCC compartment and wire numbers.
3. Character markings shall face the open panel and shall read from left to right or top to bottom.

C. Conduit Marking:
1. Furnish colored band markers for each conduit longer than six feet and mark each conduit a minimum of twenty feet on center.
2. Mark conduits where they penetrate a wall or other structure, or emerge from the ground, slab, etc.
3. Position conduit markers so they can easily be read from the floor.

3.05 TESTING AND START-UP SERVICES (NOT USED)

3.06 TRAINING (NOT USED)

END OF SECTION

SECTION 26 05 75

ELECTRICAL SYSTEMS ANALYSIS

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
    a. ANSI/NFPA 70 - National Electrical Code (NEC) and state amendments thereto.
    b. ANSI/NFPA 70E - Standard for Electrical Safety in the Workplace
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE), Specifications and Standards, current edition:
    a. IEEE 141 - Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
    b. IEEE 241 - Recommended Practice for Electric Power Systems in Commercial Buildings
    c. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
    d. IEEE 399 - Recommended Practice for Industrial and Commercial Power System Analysis
    e. IEEE 1015 - Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
    f. IEEE 1584 -Guide for Performing Arc-Flash Hazard Calculations
4. Insulated Cable Engineers Association (ICEA)
5. International Society of Automation (ISA)
6. National Electrical Manufacturers Association (NEMA)
7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), current edition.
    a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
10. International Electrical Testing Association (NETA)

a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

11. Canadian Standards Association (CSA), Specifications and Standards, current edition.
12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
13. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.

1.03 DESCRIPTION OF WORK

A. Furnish short-circuit and protective device coordination studies.

B. Furnish an Arc Flash Hazard Analysis Study per the requirements set forth in the current issue of NFPA 70E -Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584 - 2002, the IEEE Guide for Performing Arc-Flash Calculations.

C. The electrical power system studies shall encompass the following electrical equipment:

1. James Street Pump Station Electrical Infrastructure
    a. Utility service entrance
    b. Meter socket &fused disconnect
    c. Pump Station components including starters
    d. Automatic Transfer Switch
    e. Generator
2. James Street Pump Station Ground System Analysis
    a. Ground Resistance Test

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

F. Earthwork – Division 31

G. Utilities – Division 33

1.05 SUBMITTALS

A. Submit shop drawings.

B. Preliminary short-circuit and protective device coordination studies shall be submitted and approved prior to the approval of any electrical equipment submittals that may be affected by the results of the study.

C. Final short-circuit, protective device coordination, and arc flash hazard analysis studies shall be prepared and submitted based upon actual installed system characteristics.

D. Submit the following information specifically for Electrical Systems Analysis:
   1. The results of the short-circuit, protective device coordination, and arc flash hazard analysis studies shall be summarized in a final report. A minimum of five (6) bound copies of the complete final report shall be submitted. Electronic PDF copies of the report shall be provided.
   2. The report shall include the following sections:
      a. Executive Summary including Introduction, Scope of Work and Results/Recommendations.
      b. Short-Circuit Methodology Analysis Results and Recommendations
      c. Short-Circuit Device Evaluation Table
      d. Protective Device Coordination Methodology Analysis Results and Recommendations
      e. Protective Device Settings Table
      f. Time-Current Coordination Graphs and Recommendations
      g. Arc Flash Hazard Methodology Analysis Results and Recommendations including the details of the incident energy and flash protection boundary calculations, along with Arc Flash boundary distances, working distances, Incident Energy levels and Personal Protection Equipment levels.
      h. Arc Flash Labeling section showing types of labels to be provided. Section shall contain descriptive information as well as typical label images.
      i. One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, device numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis.
   3. Submit an electronic version of the software model used to prepare the final short-circuit, protective device coordination, and arc flash hazard analysis studies.
   4. Submit written certification, sealed, and signed by a professional engineer conducting the study, equipment supplier, and electrical subcontractor stating that the data used in the study is correct.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NOT USED)

1.07 FACTORY TESTING (NOT USED)

1.08 QUALITY ASSURANCE

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the responsible charge and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

B. The Registered Professional Electrical Engineer shall be an employee of the approved engineering firm.

C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

D. The approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analyses it has performed.

E. The studies shall be performed using SKM Systems Analysis Power*Tools for Windows (PTW) software program or an approved equivalent software tool.

PART 2 PRODUCTS AND MATERIALS

2.01 DATA COLLECTION

A. Field data collection shall be performed by a technician, qualified (as defined by NFPA 70E - 2014) to ensure accurate equipment modeling. The technician shall have completed an 8-hour instructor-led Electrical Safety Training Course. The course shall include NFPA 70E training which includes the selection and use of personal protective equipment.

B. The technician shall visually inspect to verify the equipment ratings, conductor ratings and overcurrent device data by removing panels, covers and doors where required to document the necessary data used in the analysis. The technician shall be qualified to perform these inspections with the equipment energized provided the incident energy values are less than 40cal/cm², greater values or unusual site conditions will require an equipment shutdown so the equipment can be inspected de-energized.

C. The Owner or Contractor shall provide qualified personnel to show the technician the equipment locations and to open all equipment doors, locks, etc. necessary to collect nameplate data.

D. Verify one-line drawings and provide marked corrections where discrepancies are found.

E. Data collection shall begin downstream from the utility service and continue down through the electrical distribution system as defined under scope of work. The study shall not include any single phase AC circuits or DC distribution systems as these types of circuits and systems are excluded from IEEE 1584-2002 Arc Flash calculation guidelines.

F. Obtain from the utility the minimum, normal, and maximum operating service voltage levels, three-phase short circuit MVA and X/R ratio, as well as line-to-ground short circuit MVA and X/R ratio at the point of connection as shown on the drawings.

2.02 SHORT-CIRCUIT ANALYSIS

A. Transformer design impedances shall be used when test impedances are not available.

B. Provide the following:
   1. Calculation methods and assumptions
   2. Selected base per unit quantities
   3. One-line diagram of the system being evaluated that clearly identifies individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis
   4. The study shall include input circuit data including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
   5. Tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment rating.
   6. Results, conclusions, and recommendations. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.

C. For solidly-grounded systems, provide a bolted line-to-ground fault current study for applicable buses as determined by the engineer performing the study.

D. Protective Device Evaluation:
   1. Evaluate equipment and protective devices and compare to short circuit ratings
   2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses

3. Identify in writing, any circuit protective devices improperly rated for the calculated available fault current.

2.03 PROTECTIVE DEVICE TIME-CURRENT COORDINATION ANALYSIS

A. Protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title with descriptive device names.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:
1. Electric utility's overcurrent protective device
2. Medium voltage equipment overcurrent relays
3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
6. Medium voltage conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points, where applicable
9. Pertinent generator short-circuit decrement curve and generator damage point
10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

G. Provide the following:
1. A one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.
2. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
3. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable

devices, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.

4. The study shall include a separate, tabular printout containing the recommended settings of all adjustable overcurrent protective devices, the equipment designation where the device is located, and the device number corresponding to the device on the system one-line diagram
5. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.
6. Identify in writing of any significant deficiencies in protection and/or coordination. Provide recommendations for improvements.

2.04 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2009, Annex D. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis and the protective device time-current coordination analysis.

B. The flash protection boundary and the incident energy shall be calculated at significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

C. Circuits 240V or less fed by single transformer rated less than 125 kVA may be omitted from the computer model and will be assumed to have a hazard risk category 0 per NFPA 70E.

D. Working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from the utility. Calculations shall take into consideration the parallel

operation of synchronous generators with the electric utility, where applicable as well as any stand-by generator applications.

G. The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

H. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:
   1. Fault contribution from induction motors should not be considered beyond 5 cycles.

I. For each piece of ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides, or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault. A second calculation shall be made for the front cubicles and shall be based on the equipment's main device to clear the arcing fault. For all other non-ANSI rated equipment, only one calculation shall be required and it shall be based on a device located upstream of the equipment to clear the arcing fault.

J. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

K. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

L. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of 2 seconds will be used based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

M. Provide the following:
   1. Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, working distances, personal-protective equipment classes and AFIE (Arc Flash Incident Energy) levels.
      a. The Arc-Flash Hazard Analysis shall report incident energy values based on recommended device settings for equipment within the scope of the study.

1) The Arc-Flash Hazard Analysis may include recommendations to reduce AFIE levels and enhance worker safety.

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK (NOT USED)

3.02 FIELD ADJUSTMENT

A. The Contractor or equipment manufacturer's start-up technician shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study.

B. The Contractor shall make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Square D shall notify Owner in writing of any required major equipment modifications.

3.03 DELIVERY, STORAGE, AND HANDLING (NOT USED)

3.04 INSTALLATION

A. Provide a 4.0 in. x 4.0 in. thermal transfer type Arc Flash label of high adhesion polyester for each work location analyzed.

B. The Arc Flash labels shall be designed according to the following standards:
1. UL969 - Standard for Marking and Labeling Systems
2. ANSI Z535.4 - Product Safety Signs and Labels
3. NFPA 70 (National Electric Code) - Article 110.16

C. The Arc Flash label shall include the following information:
1. System Voltage
    a. Flash protection boundary
    b. Personal Protective Equipment category
    c. Arc Flash Incident energy value (cal/cm^2)
    d. Limited, restricted, and prohibited Approach Boundaries
        1) Study report number and issue date

D. Labels shall be printed by a thermal transfer type printer, with no field markings.

E. Arc flash labels shall be provided for equipment as identified in the study and the respective equipment access areas per the following:
1. Floor Standing Equipment - Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have

labels provided on each individual section access area. Equipment line-ups containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis table.

2. Wall Mounted Equipment - Labels shall be provided on the front cover or a nearby adjacent surface, depending upon equipment configuration.

3. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.

F. Label Installation

1. Labels shall be field installed by the Contractor. The technician providing the installation shall have completed an 8-Hour instructor led Electrical Safety Training Course with includes NFPA 70E material including the selection of personal protective equipment.

3.05 TESTING AND START-UP SERVICES (NOT USED)

3.06 TRAINING (NOT USED)

END OF SECTION

SECTION 26 08 00

ELECTRICAL EQUIPMENT ACCEPTANCE TESTING AND START-UP

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:

B. ANSI/NFPA 70 - National Electrical Code (NEC) and state amendments thereto.

C. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:

D. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)

E. Insulated Cable Engineers Association (ICEA)

F. International Society of Automation (ISA)

G. National Electrical Manufacturers Association (NEMA)

H. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.

I. Wisconsin Department of Safety and Professional Services (DSPS).

J. National Electrical Contractors Association (NECA), current edition.
   1. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.

K. International Electrical Testing Association (NETA)

L. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

M. Canadian Standards Association (CSA), Specifications and Standards, current edition.

N. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.

O. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.

1.03 DESCRIPTION OF WORK

A. For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of:

1. Section 26 90 00 - Process Instrumentation & Control.
    a. The Contractor shall engage the acceptance testing and startup services of the field engineering service division of a major electrical distribution equipment manufacturer which maintains division-wide recognized specialized testing capabilities for the purpose of performing tests as herein specified.
    b. The tests and inspections shall determine suitability for energizing equipment; confirm the equipment is installed per the contract documents and as a benchmark for the Owner to use for future maintenance testing.

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

F. Earthwork – Division 31

G. Utilities – Division 33

1.05 SUBMITTALS

A. Submit shop drawings.

B. Submitted electrical test report shall include the following:

C. Summary of project

D. Description of equipment tested

E. Description of test

F. Test results

G. Conclusions and recommendations

H. Appendix, including appropriate test forms

I. List of test equipment used and calibration date

J. Conditions for future access to secured computer database of all Test Data.

K. Furnish three copies of the completed report to the project engineer no later than 30 days after completion of the project, unless directed otherwise.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NOT USED)

1.07 FACTORY TESTING (NOT USED)

1.08 QUALITY ASSURANCE

A. The testing plan and procedures shall be reviewed and approved by one of the field engineering division's registered professional electrical engineers. The registered professional engineer shall be a full time employee of the engineering service testing group with at least 10 years of field experience testing electrical apparatus.

B. The engineering service testing group shall be an independent division of a major electrical equipment manufacturer.

C. The engineering service division site lead engineer or project manager shall be a degreed engineer, who is a full-time employee, with at least 10 years of experience testing electrical apparatus, and has obtained factory training. All other employees working on this project shall have had specific factory, and/or field training in accordance with division-wide standards.

D. To ensure compliance with quality control standards, the engineering service division shall conduct periodic audits of test procedures and test record forms to ensure compliance with industry standards. A Quality Assurance Manager, not reporting to the operation center completing the field testing services, must complete such audits. The name of the Quality Assurance Manager, or separate audit agency, shall be submitted for approval prior to award of any contract or completion of any fieldwork.

E. All test records shall be recorded onto standardized test forms. All data shall be uploaded to a central computer in a data-secured environment; therefore ensuring no changes can be incorporated into the final test records. These records shall be

retrievable for a period of not less than five years, based on a mutually agreed periodic maintenance plan, separate from this contract.

F. Should repairs be required, the engineering service division shall maintain dedicated locations that perform remanufacturing and reconditioning of electrical equipment. All repairs shall be conducted under the direction of a quality control and reconditioning standard pursuant to ISO9001 compliance. A quality certificate, computer database and final test records shall document the progress of each piece of electrical equipment through the repair or reconditioning process. All work shall be performed in accordance with industry standards. Documentation of periodic audits, as specified in item D above, shall also be maintained for the dedicated remanufacturing and reconditioning facility.

G. The engineering service testing group shall have a calibration program which maintains all applicable test instrumentation within rated accuracy.

H. The accuracy shall be traceable to the National Bureau of Standards in an unbroken chain.

I. Instruments shall be calibrated in accordance with the following frequency schedule:

J. Field instruments – six to twelve months

K. Laboratory instruments – twelve months

L. Dated calibration labels shall be visible on all test equipment.

M. Records must be kept up to date, which show date and results of all instruments calibrated or tested.

N. An up-to-date instrument calibration instruction and procedure will be maintained for each test instrument.

1.09 WARRANTY (NOT USED)

1.10 EXTRA MATERIALS (NOT USED)

1.11 DESIGN REQUIREMENTS (NOT USED)

1.12 MAINTENANCE (NOT USED)

1.13 SAFETY AND PRECAUTIONS

A. Safety practices shall include, but are not limited to, the following requirements:

B. Occupational Safety and Health Act of 1970 – OSHA 29CFR 1910.269

C. National Fire Protection Association – NFPA 70E

D. Applicable state and local safety operating procedures.

E. All tests shall be performed with apparatus de-energized except where otherwise specified.

F. The engineering service testing group's lead test engineer for the project shall be a designated safety representative and shall be present on the project and supervise testing operations and safety requirements.

G. Power circuits shall have conductors shorted to ground by a hotline grounded device approved for the purpose in accordance with the appropriate test procedures.

H. In all cases, work shall not proceed until the safety representative has determined that it is safe to do so.

I. The engineering service testing group shall have available sufficient protective barriers and warning signs, where necessary, to conduct specified tests safely.

J. The owner's safety procedures shall be reviewed and understood by the engineering service testing group personnel.

PART 2 PRODUCTS AND MATERIALS

2.01 EQUIPMENT EVALUATION PREPARATION

A. The electrical contractor shall torque down all accessible bolts; perform continuity checks on all branch and control wiring; and perform rotational tests for all motors prior to and in addition to tests performed by the engineering service testing group, specified herein. Contractor shall remove metal shavings and thoroughly clean and vacuum equipment before testing or energizing.

B. The electrical contractor shall supply a suitable and stable source of test power for testing at each test site. The engineering service testing group shall specify requirements.

C. The electrical contractor shall notify the engineering service testing group when equipment becomes available for electrical tests. Work shall be coordinated to expedite project scheduling.

D. The contractor will supply a complete set of as-built electrical plans, specifications and any pertinent change orders to the engineering service testing group prior to commencement of testing.

E. The engineering service testing group shall notify the project engineer prior to commencement of any testing.

F. The engineering service testing group shall be responsible for implementing all final settings and adjustments on protective devices and electrical equipment in accordance with the project engineer's specified values or a coordination study performed by the engineer of record or the testing group's licensed professional engineer.

G. Any system, material or workmanship which is found defective on the basis of electrical tests shall be reported directly to the project engineer.

H. The engineering service testing group shall maintain a written record of all tests and upon completion of the project, assemble and certify a final test report.

PART 3 CONSTRUCTION METHODS

3.01 FIELD MEASUREMENTS

A. The field engineering service testing group shall provide all material, equipment, labor and technical supervision to perform electrical equipment tests and inspections. The field engineering service division of the equipment manufacturer shall administer all acceptance and start-up testing, and power system studies, as referenced in other specification sections.

B. Equipment warranty shall be extended to two years from date of commissioning when service representatives employed by the equipment manufacturer perform startup.

C. The intent of these tests is to assure that all electrical equipment is operational within industry standards and manufacturer's tolerances and that equipment is installed and functioning in the system in the manner intended by the engineer.

D. Upon completion of the tests and inspections noted in these specifications, a label shall be attached to all serviced devices. These labels will indicate date serviced and the engineering service testing group responsible.

E. The tests and inspections shall determine suitability for initial continued reliable operation.

3.02 DELIVERY, STORAGE, AND HANDLING (NOT USED)

3.03 INSTALLATION (NOT USED)

3.04 TESTING AND START-UP SERVICES

A. MCC and Switchboard Inspection and Testing

B. Examine the Main MCC, switchboard(s), including breakers, and accessories for:

C. Doors, panels, and sections for alignment, dents, scratches, fit, and missing hardware

D. Shipped loose and shipped short components.

E. Shipping damage

F. Loose or obviously damaged components.

G. Proper identification.

H. Physical damage from installation.

I. If the unit was placed in temporary storage, verify and record that proper procedures were observed. Remove temporary heater wiring and shipping braces.

J. Inspect Shipping Splits to insure that all bus connections were properly connected and all control wiring splits have been properly terminated.

K. Inspect all grounding connections for cleanliness and alignment.

L. Inspect Main Bonding Jumper for proper size and termination (Refer to NEC Article 250, Section 250-102, Equipment Bonding Jumpers).

M. Inspect Insulators for evidence of physical damage or contaminated surfaces.

N. Inspect Surge Arrester and/or Surge Suppression size, type, installation and connection to determine if they are in accordance with the drawings (Refer to NEC Article 280)

O. Inspect Control power & instrument transformers, if applicable.

P. Inspect wiring for damaged insulation, broken leads, tightness of connections, proper crimping, and overall general condition.

Q. Verify anchorage (per local codes, wind and seismic considerations).

R. Inspect and verify required area clearances, correct alignment and cleanliness.

S. Verify the grounding electrode conductor is properly sized (in accordance with NEC Article 250, Table 250-66) and terminated.

T. Confirm the proper grounding of instruments, panels and connections (Refer to NEC Article 250, Part J, Sections 250-170 through 250-178).

U. Confirm proper conductor identification (as applicable).

V. Verify cable termination tightness.

W. Verify hat all cables have been properly installed, routed and supported and are clear of energized parts.

X. Confirm conduits and conduit bushings are correctly installed.

Y. Confirm tightness of accessible bolted electrical connections, especially shipping splits, by calibrated torque-wrench method in accordance with manufacturers published data.

Z. Verify that all VT and CT ratios properly correspond to drawings and that polarity is correct.

AA. Verify that shorting screws and bars are removed from CT's and terminal blocks as required.

BB. Verify that primary and secondary fuse ratings or circuit breakers match drawings.

CC. Confirm meter scaling and type match drawings.

DD. The meter, protective relay, breaker settings (& PFC choices) must be supplied from a Power System Study performed by a licensed professional engineer prior to commissioning.

EE. Set meter, relay, & breaker trip setting per above study.

FF. Inspect shipping splits for mechanical connection assuring adequate surface contact.

GG. Ground bonding & shipping splits shall be tested with ductor tester (Digital low ohm resistance meter) to insure connection is a low resistance connection. Test from one fixed bus to adjacent fixed bus through the shipping split connector to measure both connection points.

HH. Microhm values shall not vary more than 50% from other phase readings and meet the manufactures published data based on bus size, ampacities and material.

II. Test the phase loss relay, either separate or integral to the multimeter, to activate contact.

JJ. Test the undervoltage relay, either separate or integral to the multimeter, to activate contact.

KK. If contact is hooked to the Capacitor trip & Shunt trip combo on main breaker, insure main breaker trips.

LL. If contact reports to energy management system, insure energy management system receives loss of phase/voltage signal.

MM. Inspect switchboard main bonding jumper for proper size and termination on source side of neutral disconnect link.

NN. Inspect Grounding electrode conductor to assure proper size and secure termination to ground bus.

OO. Inspect switchboard neutral bus downstream of the neutral disconnect link to verify the absence of ground connections.

PP. Set Ground fault setting per calculations in E above.

QQ. Verify Ground Fault System Performance for correct response of the circuit-interrupting device by secondary (or primary if local inspector requires) ground sensor current injection. Record ground fault pickup current. Verify breaker trips and indicator works.

RR. Verify Ground fault does not pick-up at 90% of pickup setting.

SS. Record settings, results, and any other notations on the Low Voltage Breaker data form.

3.05 CABLE TESTING

A. Insulation System – To insure integrity of the cable insulation system after shipping, site storage, and pulling through conduit an insulation resistance test will reveal insulation deformities and moisture in the cable that otherwise might cause an untimely premature cable failure possibly damaging equipment or personnel. Perform the following on all customer power cables to and from main switchboard. This would include cables from utility transformer to MSB and cables from MSB to all secondary switchboards or distribution panels.

B. Visually inspect visible portion of cables for observable defects.

C. Insure all solid-state devices are disconnected from the system prior to meggering. Typically but not all-inclusive would be Meters, trip units with voltage sensing, and TVSS units.

D. Isolate cables by opening breakers. Meggering thru equipment like motors or transformers will produce erroneous readings.

E. Perform insulation-resistance tests on each line and load cable, phase-to-phase, phase-to-ground, phase-to-neutral and neutral-to-ground in each conduit. Megger at 1000 VDC for 600 volt cable and 500 VDC for 300 volt cable for one minute.

F. Insulation resistance shall be above 100 ohms and preferably above one megohm.

G. Insure cable termination connections are tight after testing.

3.06 FOLLOW UP TESTING

1. Included in above cost as part of original project.

B. One month prior to the expiration of the factory warranty schedule & perform a thermal scan of all breaker to cable, breaker, bus connections, cable to panel chassis. Scope is to include main transformer connections, main switchboard, all secondary switchboards, transformers, and panels. Tests are to be done with building normal loaded for 2 hours, not in with partial or unloaded condition.

C. Thermal scans temperatures shall be evaluated as follows (based on comparable size or adjacent phases and loaded breakers, bus connections, and terminations)

1. 1-3 degrees C rise, Investigate as to the cause of temp rise.
2. 4 – 15 degree C rise, Repair as soon as possible.
3. 16 or higher degree C rise, Repair immediately.

D. Insure that all bus and breaker to cable connections are tight.

E. Note corrective actions taken, deficiencies, recommendations and any general comments.

F. Finish recording data on test forms, completely filling in the blanks.

G. Turn in 3 copies of report to engineer for approval.

3.07 TRAINING (NOT USED)

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
    a. ANSI/NFPA 70 - National Electrical Code.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. International Society of Automation (ISA)
6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition.
    a. NEMA PB 1 - Panelboards
    b. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
    c. NEMA AB 1 - Molded Case Circuit Breakers.
    d. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
    e. NEMA 250 - Enclosures for Electrical Equipment.
7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
    a. UL 50 - Enclosures for Electrical Equipment
    b. UL 67 - Panelboards.
    c. UL 98 - Enclosed and Dead-front Switches
    d. UL 489 - Molded-Case Circuit Breakers and Circuit Breaker Enclosures
8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), current edition.
    a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
10. International Electrical Testing Association (NETA)
    a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

11. Canadian Standards Association (CSA), Specifications and Standards, current edition:
    a. CSA Standard C22.2 No. 29-M1989 - Panelboards and Enclosed Panelboards
    b. CSA Standard C22.2 No. 5-M91 - Molded Case Circuit Breakers
12. Federal Specifications and standards, current edition:
    a. W-P-115C - Type I Class 1
    b. W-C-375B - Molded Case Circuit Breakers
    c. W-C-375B/Gen - Circuit Breakers, Molded Case, Branch Circuit and Service.
    d. W-P115C - Type 1 Class 2 Load Center

1.03 DESCRIPTION OF WORK

A. Furnish and install complete and operable panelboards as indicated on the drawings and as specified herein.

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

F. Earthwork – Division 31

G. Utilities – Division 33

1.05 SUBMITTALS

A. Submit shop drawings.

B. Submit the following information specifically for panelboards:
1. Literature sufficient in scope to demonstrate compliance with the requirements of this specification.
2. Overall panelboard dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. Illustrate one line diagrams with applicable voltage systems.
3. Equipment ratings for voltage, amperage, and short circuit.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation & maintenance manuals and instructions.

B. Submit the following information specifically for panelboards:
   1. Manufacturer shall provide installation instructions and NEMA Standards Publication PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

1.07 FACTORY TESTING (NOT USED)

1.08 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications: All panelboards provided under this section shall be the products of a single company specializing in manufacturing products specified in this section, with not less than fifty years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

E. Panelboard manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.09 WARRANTY

1.10 EXTRA MATERIALS

1.11 DESIGN REQUIREMENTS (NOT USED)

1.12 MAINTENANCE

A. Before substantial completion, perform all maintenance activities required by any sections of the specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems into service.

B. Furnish all spare parts as required by other sections of the specifications.

PART 2 PRODUCTS

2.01 240VAC LIGHTING AND APPLIANCE BRANCH CIRCUIT LOAD CENTERS

A. Manufacturers:

1. Square D Company QO Load Center
~~2. Cutler-Hammer Type CH~~
~~3. or equal~~

B. Interiors:
1. Bus bar connections to the branch circuit breakers shall be the distributed phase type and shall accept plug-on circuit breakers. 300-400A load centers shall accept a 150A maximum bolt-on breaker in addition to plug-on types.
2. Short Circuit Current Ratings: shall be provided as indicated on the drawings. This rating shall be established by manufacturer testing of a representative load center with branch circuit breakers installed.

C. Circuit Breakers:
1. Circuit breakers shall be plug-on thermal magnetic trip, with an integral crossbar to ensure simultaneous opening of all poles in multi-pole circuit breakers.
2. Circuit breakers shall have an overcenter, tripfree, toggle-type operating mechanism with quick-make, quick-break action and positive handle indication.
3. Handles shall have ON, OFF, and "Tripped" positions. In addition, trip indication shall include an indicator appearing in the window of the circuit breaker case (through 125 amperes).
4. Circuit breakers shall be UL Listed in accordance with UL standard 489 with current ratings as indicated on the plans. Interrupting ratings shall be selected to provide the required load center short circuit current rating.
5. Single-pole, 15 and 20 ampere circuit breakers indicated on the drawings as intended to switch fluorescent lighting loads on a regular basis shall have the SWD marking.
6. Two- and three-pole circuit breakers 15-60 amperes indicated on the drawings as intended for use with air conditioning, heating, and refrigeration equipment having motor group combinations and marked as such shall have the HACR marking.
7. Provide UL Class A ground fault interrupter circuit breakers where indicated on drawings.
8. The following special application circuit breakers or circuit breaker accessories shall be provided where indicated on the drawings:
    a. Circuit breakers with remote control switching capability
    b. Circuit breakers for use on high intensity discharge lighting systems
    c. Key operated circuit breakers
    d. Switch neutral circuit breakers
    e. Shunt trip, auxiliary switch, or alarm switch accessories

D. Enclosures:
1. NEMA PB1: Type 1 or Type 3R as indicated on the drawings.
2. Enclosure shall be fabricated of cold rolled steel for NEMA 1 and galvannealed steel or equivalent rust-resistant steel for NEMA 3R.

3. Indoor Type l enclosures shall have a flush or surface front as indicated on the drawings and flush cylinder tumble-type lock, all keyed alike, with finish to be gray baked enamel.
4. Outdoor Type 3R enclosures shall have a hasp to secure the cover. Finish to be gray baked enamel.
5. A directory label shall be provided with circuits identified as indicated on the schedule.

E. Manual Transfer Assembly:
1. Provide U.L. Listed manual transfer assembly where indicated on the drawings.
2. Manual transfer shall consist of two backfed main circuit breakers sized as indicated on the drawings complete with retaining kits and mechanical interlock to prevent both circuit breakers from simultaneously being in the "on" position.

2.02 240VAC LIGHTING AND APPLIANCE PANELBOARDS

A. Manufacturers:
1. Square D Company NQ
~~2. Cutler-Hammer Pow-R-Line~~
~~3. or equal~~

B. Interior:
1. Rated for 240VAC / 48VDC maximum. Continuous main current ratings, as indicated on the drawings, not to exceed 600 amperes maximum.
2. UL Listed short circuit current ratings as indicated on the drawings with a maximum of 200,000 RMS symmetrical amperes.
3. Provide one continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors suitable for plug-on or bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67. Bussing shall be plated copper. Bus bar plating shall run the entire length of the bus bar. Main lug and main breaker panelboards shall be suitable for use as Service Equipment.
4. All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.
5. A solidly bonded copper equipment ground bar shall be provided. An additional copper isolated/insulated ground bar shall also be provided where indicated on the drawings.
6. Split solid neutral shall be plated and located in the mains compartment up to 225 amperes so all incoming neutral cable may be of the same length. UL Listed panelboards with 200 percent rated solid neutrals shall have plated copper neutral bus for non-linear load applications where indicated on the drawings.

7. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have pre-formed twist-outs covering unused mounting space.
8. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, UL Listed label and short circuit current rating shall be displayed on the interior or in a booklet format.
9. Interiors shall be field convertible for top or bottom incoming feed. Main lug interiors up to 400 amperes shall be field convertible to main breaker. Interior leveling provisions shall be provided for flush mounted applications.
10. Circuit Breakers:
    a. Main circuit breakers shall be vertically mounted.
    b. Sub-feed circuit breakers shall be vertically mounted.
    c. Molded case branch circuit breakers shall have bolt-on type bus connectors.
    d. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.
    e. The exposed faceplates of all branch circuit breakers shall be flush with one another.

C. Enclosures:
1. Type 1:
    a. Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Zinc-coated galvannealed steel will not be acceptable.
    b. Boxes shall have removable endwalls with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.
    c. Box width shall be 26-inch wide maximum.
    d. Type 1 Fronts:
        1) Front shall meet strength and rigidity requirements per UL 50 standards. Front shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
        2) Fronts shall be hinged 1-piece with door. Mounting shall be flush or surface as indicated on the drawings.
        3) Panelboards shall have fronts with concealed door hinges and mounted with trim screws. Front shall not be removable with the door locked. Doors on front shall have rounded corners and edges shall be free of burrs.
        4) Front shall have cylindrical tumbler type lock with catch and spring-loaded stainless steel door pull. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory cardholder shall be mounted on the inside of door.

2. Type 3R, 5, and 12:
   a. Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
   b. All doors shall be gasketed and equipped with a tumbler type vault lock and two (2) additional quarter turn fasteners on enclosures 59-inches or more in height. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory cardholder shall be mounted on the inside of door.
   c. Maximum enclosure dimensions shall not exceed 21-inches wide and 6.5-inches deep.

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK (NOT USED)

3.02 FIELD MEASUREMENTS

A. Field verify all measurements. Do not base exact panelboard locations on the contract drawings. Actual field conditions govern all final installed locations, distances, and levels.

B. Identify conflicts with the work of other trades prior to installation of electrical equipment.

C. Adjust panelboard installation to satisfy field requirements.

3.03 DELIVERY, STORAGE, AND HANDLING

A. Accept panelboard on site. Inspect for damage.

B. Protect panelboard from corrosion and entrance of debris.

C. Store panelboard above grade. Protect from environment with suitable covering.

3.04 INSTALLATION

A. Install panelboards plumb and flush with wall finishes.

B. Install panelboards such that top of panel is located at an elevation of 6-feet above finished floor elevation.

C. Provide filler plates for unused spaces in panelboards.

D. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

E. Stub one empty 1.5-inch conduit to accessible location below ground outside concrete slab.

F. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 10 percent, rearrange circuits in the panelboard to balance the phase loads within 10 percent. Take care to maintain proper phasing for multi wire branch circuits.

G. Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

H. Verify that bonding jumper is properly installed in service entrance rated panels.

I. Thoroughly clean and remove construction debris from panelboard interior and exterior.

3.05 TESTING AND START-UP SERVICES

A. Refer to the requirements of Section 26 08 00 - Commissioning of Electrical Systems.

3.06 TRAINING

A. Refer to the requirements of Section 26 08 00 - Commissioning of Electrical Systems.

END OF SECTION

SECTION 26 28 19

ENCLOSED SWITCHES

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS

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    a. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
        1) ANSI/NFPA 70 - National Electrical Code (NEC) and state amendments thereto.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. International Society of Automation (ISA)
6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition.
    a. NEMA FU 1 - Low Voltage Cartridge Fuses
    b. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
    c. NEMA 250 - Enclosures for Electrical Equipment.
7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
    a. UL 98 - Enclosed and Dead Front Switches
    b. UL 508 – Standard for Industrial Control Equipment
8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), current edition.
    a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
10. International Electrical Testing Association (NETA)
    a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

11. Canadian Standards Association (CSA), Specifications and Standards, current edition:
12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
13. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.

1.03 DESCRIPTION OF WORK

A. Furnish and install complete and operable enclosed switches as indicated on the drawings and as specified herein.

B. Provide disconnect switches with the number of poles, voltage, current, short circuit, and horsepower ratings as required by the load and the power system.

C. Furnish one spare set of fuses.

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

F. Earthwork – Division 31

G. Utilities – Division 33

1.05 SUBMITTALS

A. Submit shop drawings.

B. Submit the following information specifically for enclosed switches:
1. Manufacturer literature sufficient in scope to demonstrate compliance with the requirements of this specification.
2. Outline drawings with dimensions.
3. Equipment ratings for voltage, amperage, horsepower and short circuit.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NOT USED)

1.07 FACTORY TESTING (NOT USED)

1.08 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.09 WARRANTY

1.10 EXTRA MATERIALS

A. Supply 3 spare fuses of each type supplied for this project

1.11 DESIGN REQUIREMENTS (NOT USED)

1.12 MAINTENANCE (NOT USED)

PART 2 PRODUCTS AND MATERIALS

2.01 250VAC/600VAC HEAVY DUTY DISCONNECT SWITCH

A. Manufacturers:
1. Schneider Electric/Square D Company
2. ~~Eaton/Cutler-Hammer~~
2. Allen Bradley
3. or equal

B. Switch Interior:
1. All switches shall have switch blades which are visible when the switch is off and the cover is open.
2. Lugs shall be front removable and UL Listed for 60 degree C or 75 degree C aluminum or copper conductors as required by the application.
3. Fusible switches shall be equipped with factory installed or field installed fuse pullers.
4. Switches shall be equipped with plated copper current carrying parts to resist corrosion.
5. Switches shall be equipped with removable arc suppressors to facilitate access to line side lugs.
6. Switches shall have provisions for a field installable electrical interlock.

C. Switch Mechanism:
   1. Switch operating mechanism shall be quick-make, quick-break such that, during normal operation of the switch, the operation of the contacts shall not be restrained by the operating handle after the closing or opening action of the contacts has started.
   2. The operating handle shall be an integral part of the box, not the cover.
   3. The handle position shall travel at least 90 degrees between off and on positions to clearly distinguish and indicate handle position.
   4. All switches shall have a dual cover interlock mechanism to prevent unintentional opening of the switch cover when the switch is on and prevent turning the switch on when the cover is open. The cover interlock mechanism shall have an externally operated override but the override shall not permanently disable the interlock mechanism. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

D. Switch Enclosures:
   1. Environmental Rating:
      a. Service entrance switch, exterior: Type 4X, stainless steel.
      b. Service entrance switch, interior: Type 1.
      c. Disconnect switch, exterior: Type 4X, stainless steel.
      d. Disconnect switch, interior: Type 4X, stainless steel.
      e. Disconnect switch, interior when EMT conduit is allowed: Type 1.
      f. Disconnect switch, hazardous location: Type 7/9.
   2. Covers:
      a. Type 1, 4X stainless steel enclosures: attached with welded pin-type hinges.
      b. Type 7/9 enclosures: attached with Type 316 stainless steel bolts.
   3. Finish:
      a. Type 1 enclosures: gray baked enamel paint electrodeposited on cleaned, phosphate pre-treated steel.
      b. Type 4X stainless steel enclosures: brush finish on type 304 stainless steel.
      c. Type 7/9 enclosures: gray baked enamel on copper free cast aluminum alloy.
   4. The enclosure shall have on and off markings stamped or cast into the cover.
   5. The operating handle shall be provided with a dual colored, red/black position indication.
   6. All switches shall have provisions to accept up to three 3/8-inch hasp padlocks to lock the operating handle in the off position.
   7. Exterior switches shall have provisions to accept one 3/8-inch hasp padlocks to lock the operating handle in the on position.
   8. Conduit Entrance:
      a. Tangential knockouts shall be provided for Type 1 switches rated 30-200A.

b. Watertight conduit hubs for Type 4X stainless steel switches.
c. Threaded conduit openings in both end walls for Type 7/9 enclosures.

9. Cover sealing means for switches rated through 200 amperes shall be quick release trunk latches (Type 1, 4X stainless steel enclosures) and type 316 stainless steel bolts (Type 7/9 enclosures).
10. Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor applications.
11. Type 4X stainless steel enclosures shall be dual rated as Type 3R to facilitate their use in outdoor applications.

E. Switch Ratings:
1. Switch shall be suitable for use as service entrance equipment where use is indicated on the drawings.
2. Switches shall be horsepower rated for ac and/or dc as indicated on the plans.
3. Switches shall be rated for the voltage applied.
4. The UL Listed short circuit current rating of the switches shall be:
a. 10,000 rms symmetrical amperes when used with or protected by Class H or K fuses (30-600 ampere).
b. 200,000 rms symmetrical amperes when used with or protected by Class R or Class J fuses (30-600 ampere switches employing appropriate fuse rejection schemes).
c. 200,000 rms symmetrical amperes when used with or protected by Class L fuses (800-1200 ampere).

2.02 FUSES

A. Manufacturers:
1. Bussmann
2. or equal

B. 250 Volt Fuses:
1. Class RK-1, one end rejection or to fit mountings specified. 0-600 ampere, 200,000 ampere interrupting rating.
2. Low-Peak LPN-R, dual element, time delay with short circuit protection for motor, transformer, feeder and main service protection.

C. 600 Volt Fuses:
1. Class RK-1, one-end rejection or to fit mountings specified, 0-600 ampere, 200,000 ampere interrupting rating.
2. Low-Peak LPS-R, dual element, time delay with short circuit protection. 0-600 ampere, 200,000 ampere interrupting rating for motor, transformer, feeder and main service protection.
3. Class L, bolt-in, 601-6,000 amperes, 200,000 ampere interrupting rating.

4. HI-CAP KRP-C, time delay for overload and short circuit protection. 601-6,000 amperes, 200,000 ampere interrupting rating for motor, transformer, feeder and main service protection.
5. Class CC, fast acting, single element, 0-30 amperes, 200,000 ampere interrupting rating.

2.03 SPARE FUSES

A. Provide one complete set of spare fuses.

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK (NOT USED)

3.02 FIELD MEASUREMENTS

A. Field verify all measurements. Do not base exact enclosed switch locations on the contract drawings. Actual field conditions govern all final installed locations, distances, and levels.

B. Identify conflicts with the work of other trades prior to installation of electrical equipment.

C. Adjust enclosed switch installation to satisfy field requirements.

3.03 DELIVERY, STORAGE, AND HANDLING

A. Accept enclosed switches on site. Inspect for damage.

B. Protect enclosed switches from corrosion and entrance of debris.

C. Store enclosed switches above grade. Protect from environment with suitable covering.

3.04 INSTALLATION

A. Install fuses where switches are indicated as fusible switches on the drawings.

B. Install wall mounted enclosure for spare fuses.

C. Install enclosed switches plumb and level.

D. Install enclosed switches such that top of enclosure is located at an elevation of 6-feet above finished floor elevation.

E. Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections.

F. Verify that bonding jumper is properly installed in service entrance rated switches.

G. Thoroughly clean and remove construction debris from switch interior and exterior.

3.05 TESTING AND START-UP SERVICES

A. Refer to the requirements of Section 26 08 00 - Electrical Equipment Acceptance.

3.06 TRAINING

A. Refer to the requirements of Section 26 08 00 - Electrical Equipment Acceptance.

END OF SECTION

SECTION 26 29 13

MOTOR CONTROLLERS

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
    a. ANSI/NFPA 70 - National Electrical Code (NEC) and state amendments thereto.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. International Society of Automation (ISA)
6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition.
    a. ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
    b. ICS 4-2000 - Industrial Control and Systems: Terminal Blocks.
    c. ICS 5-2000 - Industrial Control and Systems: Control Circuit and Pilot Devices.
    d. ICS 6-1993 - Industrial Control and Systems Enclosures.
7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
    a. UL 508 – Standard for Industrial Control Equipment.
    b. UL 508A – Standard for Industrial Control Panels
8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), current edition.
    a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
10. International Electrical Testing Association (NETA)
    a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
11. Canadian Standards Association (CSA), Specifications and Standards, current edition.

12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
13. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.
    a. IEC-60439 - Low Voltage Switchgear and Control Gear Assemblies.
14. European Committee for Electrotechnical Standardization (CENELEC), Current Edition.
    a. EN 60947 - Low-Voltage Switchgear and Controlgear - Part 4-2: Contactors and Motor-Starters - AC Semiconductor Motor Controllers and Starters
15. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.

1.03 DESCRIPTION OF WORK

A. For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of:
   1. Section 26 90 00 - Process Instrumentation & Control

B. Furnish and install complete and operable motor controllers as indicated on the drawings and as specified herein.

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

F. Earthwork – Division 31

G. Utilities – Division 33

1.05 SUBMITTALS

A. Submit shop drawings.

B. Submit Manufacturer literature sufficient in scope to demonstrate compliance with the requirements of this specification.

C. Submit shop drawings for the equipment specified herein in accordance with the requirements specified under Section 26 24 19, which state that submittals for all motor control equipment be included as part of the submittal for the complete, integrated process instrumentation and control system and in accordance with the requirements specified under Section 26 90 00.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation & maintenance manuals and instructions.

B. Submit operation and maintenance manuals for the equipment specified herein in accordance with the requirements specified under Section 26 24 19, which state that submittals for all motor control equipment be included as part of the submittal for the complete, integrated process instrumentation and control system and in accordance with the requirements specified under Section 26 90 00.

1.07 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications: All motor controllers provided under this section shall be the products of a single company specializing in manufacturing products specified in this section, with not less than twenty years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

E. Motor Control Center manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.08 WARRANTY

A. See Division 01 for additional requirements.

1.09 EXTRA MATERIALS

A. See Division 01 for additional requirements.

1.10 EXTRA MATERIALS (NOT USED)

1.11 DESIGN REQUIREMENTS (NOT USED)

1.12 MAINTENANCE

A. Before substantial completion, perform all maintenance activities required by any sections of the specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems into service.

PART 2 PRODUCTS AND MATERIALS

2.01 MANUFACTURER

A. Allen-Bradley 509 Nema Starter with E300 Overload.

2.02 ELECTROMECHANICAL MOTOR CONTROLLERS

A. Overload Protection:
   1. General:
      a. E300 overload
      b. Nema Overload Relay
      c. Sensing Type: Voltage/Current/Ground Fault
      d. Current Range: 0.5A-30A
      e. Mounting: Mounts on Nema size 0-2
      f. Control Voltage: 120 VAC- 4 In/ 3 Out
      g. Ethernet/IP Communications Module
      h. Provide shielded Ethernet cable 600V rated.

B. Non-Reversing Starters:
   1. Magnetic starters through NEMA Size 9 shall be equipped with double-break silver alloy contacts. The starter must have straight-through wiring. Each starter shall have one (1) NO auxiliary contact
   2. Coils shall be permanently marked with voltage, frequency and part number
   3. NEMA Size 00 through 2 starters shall be suitable for the addition of at least six (6) external auxiliary contacts of any arrangement normally open or normally closed. Size 3 through 8 starters shall be suitable for the addition of up to eight (8) external auxiliary contacts of any arrangement normally open or normally closed
   4. Allen Bradley 500 Series Nema Starter

~~2.03 SOLID-STATE REDUCED-VOLTAGE MOTOR CONTROLLERS~~

~~A. Manufacturer:~~

1. Allen-Bradley SMC-Flex.

B. Ratings:
1. The solid state reduced voltage controller shall accept an input voltage of 480 VAC, three phase plus or minus 10 percent
2. Environmental Ratings
a. Storage ambient temperature range: -20 to 75 degrees C.
b. Operating ambient temperature range: 0 to 40 degrees C.
c. The relative humidity range: 5 to 95 percent non-condensing.
d. Operating elevation: up to 2000 Meters.

C. Design:
1. The open-type controller device shall be modular, consisting of a power structure and a logic component.
2. Power Structure:
a. The power structure shall include an SCR bypass.
b. The power structure shall include a built-in overload.
c. For ratings 1 Amps to 1200 Amps, the power structure shall consist of three power poles with integral heatsinks.
d. Power poles are to be modular in design that each is easily replaceable.
e. Back-to-back SCR pairs shall be the only power switching semiconductor means acceptable. Diode-SCR (Silicon Controlled Rectifier) combinations shall not be acceptable.
f. SCRs shall have the following minimum repetitive peak inverse voltage ratings.
1) 1400V for units rated 200 to 480V
2) 1600V for units rated 200 to 600V
3. Logic Component:
a. The logic component shall be a self-contained control module, compatible with the full range of power structures. The control module shall mount directly to the power structure.
b. The control module shall provide digital microprocessor control and supervision of all controller operation, including pulse firing of the SCRs.
c. The control module shall consist of the following.
1) Self-tuning power supply accepting control power input from 100 to 240 VAC or 24V AC/DC, 50/60 Hz.
2) Logic control circuitry incorporating a latch circuit for three-wire control.
3) SCR firing circuitry that incorporates an RC snubber network to prevent false firing.
4) Input / output circuitry
5) Digital programming keypad

6) Backlit LCD display
7) DPI communication port.

d. The control module shall be easily removed from the power structure, without the need to disassemble associated printed circuit board assemblies.

e. The control terminals shall be easily accessible and located on the front top of the device. The terminals shall be UL rated for 300 Volts, 10 Amps maximum and accept a maximum of two wires rated number 18 to number 14 AWG.

D. Features:

1. Starting Modes:

a. The controller shall provide the following starting modes as standard.

1) Soft Start with Selectable Kickstart:

a) Programmable initial torque value of 0 to 90 percent of locked rotor torque

b) Programmable acceleration ramp time from 0 to 30 seconds

c) A selectable kickstart, or boost, shall be provided at the beginning of the voltage ramp. The kickstart shall provide a current pulse of 550 percent of the full load current. The kickstart time shall be adjustable from 0 to 2 seconds.

2) Current Limit Start:

a) Provides means of limiting the maximum starting current

b) Programmable for 50 to 600 percent of full load current

3) Full Voltage Start:

a) Provides across the line starting.

b) Ramp time shall be less than 0.25 seconds.

4) Dual Ramp Start:

a) Provides two separate soft start profiles with separately adjustable ramp times and initial torque settings.

b) Programmable acceleration times from 0 to 30 seconds.

c) Programmable initial torque values from 0 to 90 percent of locked rotor torque.

5) Soft Stop:

a) The Soft Stop option shall provide a voltage ramp-down for an extended motor stopping time.

b) Soft Stop shall be initiated by a dedicated Soft Stop input. A coast-to-rest stop shall still be possible with a separate stop input.

c) Programmable voltage ramp down time from 0 to 60 seconds.

d) The load shall stop when the motor voltage drops to a point where the load torque is greater than the motor torque.

6) Preset Slow Speed:

a) Provides a slow speed for applications requiring a slow speed

b) The Preset Slow Speed option shall provide two jog speeds in the forward direction: high (15 percent of base speed) and low (7 percent of base speed).

c) The Preset Slow Speed option shall provide two jog speeds in the reverse direction: high (20 percent of base speed) and low (10 percent of base speed). Reverse operation of the motor shall be available in the jog mode without the use of a reversing contactor.

d) The starting current for the slow speed operation shall be user adjustable from 0 to 450 percent of the motor's full load current rating.

e) The running current for the slow speed operation shall be user adjustable from 0 to 450 percent of the motor's full load current rating.

7) Pump Control:

a) The Pump Control option shall be implemented to provide closed loop control of a motor to match the specific torque requirements of centrifugal pumps for both starting and stopping. This shall aid in eliminating the phenomena commonly referred to as "water hammer." Methods utilizing Soft Start with Soft Stop shall not be acceptable.

b) Closed loop control shall be achieved without using external sensors or feedback devices.

c) Pump Stop shall be initiated by a dedicated Pump Stop input. A coast-to-rest stop shall still be possible with a separate stop input.

d) Programmable starting time from 0 to 30 seconds.

e) Programmable stopping time from 0 to 120 seconds.

2. LCD Display:

a. An alphanumeric, backlit LCD display shall be provided for controller set-up, diagnostics, status and monitoring. The display shall be four-line, 16 characters minimum.

b. Digital parameter adjustment shall be provided through a keypad. Analog potentiometer adjustments are not acceptable.

3. Overload Protection:
   a. Shall meet applicable standards as a motor thermal protective device.
   b. Shall utilize three-phase current sensing. The use of two current transformers shall be unacceptable.
   c. Selectable trip classes of 10, 15, 20 and 30 shall be provided as standard.
   d. Electronic thermal memory shall provide enhanced motor protection.
4. Digital I/O:
   a. A minimum of four auxiliary contacts shall be provided for customer use.
   b. The contacts shall be rated for 240 Volts AC maximum.
   c. Contact configuration shall contain:
      1) Normal/Up-to-Speed/Bypass
      2) Fault
      3) Alarm
      4) Normal
5. DPI Serial Communication Port:
   a. A DPI serial communication port shall be provided as standard.
   b. Provide communication protocol interface modules for connection to DeviceNet.
6. Monitoring:
   a. The controller shall provide the following monitoring functions indicated through the LCD display.
      1) Three-phase current
      2) Three-phase voltage
      3) Power in kW
      4) Power usage in kWh
      5) Power factor
      6) Motor thermal capacity usage
      7) Elapsed time
7. Protection and Diagnostics:
   a. The following protection shall be provided as standard with the controller.
      1) Pre-start line fault advising of shorted SCR or missing load connection with phase indication
      2) Running line fault advising power loss, shorted SCR or missing load connection.
      3) Pre-start power loss with phase indication
      4) Over temperature
      5) Open Gate with phase indication

b. The following defeatable protection shall be provided as standard with the controller.
1) Underload
2) Undervoltage
3) Overload
4) Overvoltage
5) Voltage Unbalance
6) Excessive Starts Per Hour
7) Phase Reversal
8) Stall
9) Jam
c. When fault conditions are detected, the controller shall inhibit starting or shut down SCR pulse firing.
d. Fault diagnostics shall be indicated in descriptive text on the LCD display. The exclusive use of fault codes is unacceptable.
e. An auxiliary contact that is programmable for fault indication shall be provided for customer use.

E. System Components:
1. Transient Protection Modules:
a. Transient protection with separately mounted protective modules.
b. Protective modules shall consist of metal oxide varistors (MOVs) in combination with capacitors to protect the power components from electrical transients and / or electrical noise. The capacitors shall be provided to shunt noise energy away from the controllers electronics.
c. The MOVs and capacitors shall be encapsulated in a clear material for easy inspection.
d. The protective modules shall be mounted so that they will not cause damage to the power components upon absorbing an electrical transient.
e. The MOVs shall be rated for a minimum of 220 joules.
2. Input Circuit Breaker:
a. Provide a door interlocked thermal magnetic circuit breaker disconnect
b. Operator Handles:
1) Provide flange mounted operator handles for free standing units
2) Through the door operating handles are acceptable for wall mounted units
3) Refer to requirements of Section 26 24 19 for motor control center mounted equipment.
4) Handles shall be padlockable

~~c. The system shall be rated for the available fault current identified on the drawings. The rating shall be shown on the system label.~~

~~3. Isolation Contactor~~

~~a. Input contactor shall provide positive isolation of the solid-state controller from line power to prevent leakage current through the SCRs.~~

~~b. Input contactor shall close when motor is signaled to start, energizing the solid-state controller and allowing reduced voltage starting.~~

~~c. Input contactor shall open after the solid-state controller has stopped the motor and de-energize the solid-state controller.~~

~~d. Input contactor shall not switch loaded motor under any circumstances.~~

~~4. Bypass (Shorting) Contactor~~

~~a. Bypass contactor shall close and positively short circuit the SCRs after the motor has attained full voltage running condition.~~

~~b. Bypass contactor shall open when motor is signaled to stop, allowing the SCRs to control stopping of the motor.~~

~~c. Bypass contactor shall not switch loaded motor under any circumstances.~~

~~5. Control Power Transformer:~~

~~a. Provide a control power transformer mounted and wired inside of the system enclosure.~~

~~b. The transformer shall be rated for an additional 100 VA for customer use.~~

~~c. The transformer shall be provided with fused primary and secondary protection.~~

~~6. Pilot Control Devices:~~

~~a. Provide front of panel mounted pilot devices as shown on drawings.~~

~~7. Human Interface Module:~~

~~a. Provide a door mounted Human Interface Module with integral display and programming keys.~~

~~b. The display shall show operating conditions, adjustments and fault indications.~~

~~c. The display shall be backlit LCD and shall consist of four lines of 16 characters alphanumeric.~~

~~2.04~~2.03 ENCLOSURES

A. The enclosure shall be NEMA 1 as indicated on the contract drawings.

B. Starters shall have an adjustable instantaneous motor circuit protector (HMCP) type disconnect device.

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK (NOT USED)

3.02 FIELD MEASUREMENTS

A. Field verify all measurements. Do not base exact motor controller locations on the contract drawings. Actual field conditions govern all final installed locations, distances, and levels.

B. Identify conflicts with the work of other trades prior to installation of electrical equipment.

C. Identify deviation from physical sizes shown on the drawings to Engineer prior to bid date.

D. Contractor shall be responsible for modifications to the installation due to deviations from physical sizes shown on the drawings.

E. Identify conflicts with the work of other trades prior to installation of electrical equipment.

F. Record nameplate data for each motor served.

G. Adjust motor controller installation to satisfy field requirements.

3.03 DELIVERY, STORAGE, AND HANDLING

A. Accept motor controller on site. Inspect for damage.

B. The Contractor shall be responsible for all equipment necessary to receive, unload, move into building, and install motor control centers.

C. Conform to written instructions of manufacturer.

D. Protect motor controllers from corrosion and entrance of debris.

E. Store motor controllers above grade. Protect from environment with suitable covering.

3.04 INSTALLATION

A. Adjust disconnecting means trip settings to satisfy motor nameplate requirements.

B. Provide overload relays sized and adjusted for the actual nameplate data recorded for each motor. No additional compensation will be allowed due to failure to select overload devices based upon actual motor nameplate data.

C. Record information for motor data labels and install motor data labels.

D. Install motor controllers plumb and flush with wall finishes.

E. Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of all connections.

F. Thoroughly clean and remove construction debris from panelboard interior and exterior.

3.05 TESTING AND START-UP SERVICES

A. Refer to the requirements of Section 26 08 00 - Electrical Equipment Acceptance

B. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

3.06 TRAINING

A. Refer to the requirements of Section 26 08 00 - Electrical Equipment Acceptance.

B. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

END OF SECTION

SECTION 26 32 13

STANDBY ENGINE/GENERATOR SET

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS (NONE)

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs.

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
    a. NFPA70 – National Electrical Code (NEC) and state amendments thereto. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
    b. NFPA99 – Essential Electrical Systems for Health Care Facilities.
    c. NFPA110 – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1prototype tests required by this standard shall have been performed on a complete and functional unit; component level type tests will not substitute for this requirement.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE), Specifications and Standards, current edition.
    a. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
4. Insulated Cable Engineers Association (ICEA)
5. International Society of Automation (ISA)
6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition.
    a. NEMA ICS10-1993 – AC Generator sets.
7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
    a. UL 2200. The genset shall be listed to UL 2200 or submit to an independent third party certification process to verify compliance as installed.
8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), current edition.
    a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
10. International Electrical Testing Association (NETA)

11. Canadian Standards Association (CSA), Specifications and Standards, current edition.
    a. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
    b. CSA 282, 1989 Emergency Electrical Power Supply for Buildings.
12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
    a. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.IEC8528 part 4. Control Systems for Generator Sets.

1.03 DESCRIPTION OF WORK

A. Provide complete factory assembled generator set equipment with standard analog controls.

B. Provide factory test, startup by a supplier authorized by the manufacturer, and on-site testing of the system.

C. The generator set manufacturer shall warrant all equipment provided under this section, whether or not is manufactured by the generator set manufacturer, so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.

D. Standby Engine Generator set shall be provided with the following:
1. Certified from the factory for Tier 3 compliance with all emission guidelines. The Supplier shall include all cost related to any test and certifications that are required of natural gas fueled engine-generator sets for the first 5-years of service.
2. All units shall be supplied with 5-Year Comprehensive Warranty.
3. Unit shall utilize PMG excitation.
4. Supplier shall confirm sizes provided herein meet or exceed actual facility electrical requirements. Final size, performance, and operation shall be inclusive to the Contract.
5. Unit shall include the following factory installed accessories:
    a. AC Entrance Box
    b. Battery(s)
    c. Weather protective sound attenuated steel enclosure.
    d. Main Line Circuit Breaker
    e. Oil drain extension.
    f. Coolant drain extension.
    g. Spring Isolator and vermin guard skirts.
6. Fuel supply system configuration and coordination. Supplier shall supply required regulator, galvanized piping and hardware, flex pipe connector for vibration isolation.
7. Battery charger shall be ATS mounted.

1.04 RELATED WORK ELSEWHERE

A. For the purpose of obtaining a complete and integrated standby power system, the following sections shall be included under the scope of this section:
   1. Section 26 05 19 – Low-voltage Conductors and Cables
   2. Section 26 09 07 – Automatic Transfer Control
   3. Section 26 09 11 – Protective Relay
   4. Section 26 36 23 - Transfer Switch.

B. The following sections include work which is related to the Standby Engine/Generator Set, but which is not included under the scope of this section:

C. Article 102 – Bidding Requirements and Conditions

D. Article 103 – Award and Execution of the Contract

E. Concrete – Division 03

F. Metals – Division 05

G. Electrical - Division 26

H. Earthwork – Division 31

I. Utilities – Division 33

1.05 SUBMITTALS

A. Submit shop drawings.

B. General requirements specific to this section include:
   1. Submit complete and integrated document containing all equipment included under the scope of this section.
   2. Submittal shall be complete, neat, orderly, and indexed with tabbed dividers. Partial submittals will not be accepted.
   3. Include a complete list of proposed exceptions to and deviations from these specifications.
   4. Clarity and completeness are of prime importance. Acceptability of submittal drawings shall be at the sole discretion of the Engineer in regards to this requirement.
   5. Additional requirements for the various subsystems are specified in the corresponding sections.

C. Submit the following information:
   1. Manufacturer’s product literature and performance data, sufficient to verify compliance to specification requirements.
   2. A paragraph-by-paragraph specification compliance statement, describing the differences between the specified and the proposed equipment.

3. Manufacturer’s certification of prototype testing.
4. Manufacturers published warranty documents signed by an officer of the company.
5. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
6. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
7. Manufacturer's installation instructions.
8. Control descriptions and/or logic diagrams
9. Detailed list of special tools and recommended spare parts with quantity, pricing, and supplier.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit Operation/Maintenance Manuals.

B. Submit final revised shop drawings incorporating any modifications made as a result of installation, start-up, operational testing, or for any other cause. Submit results of all field-testing and corrective actions taken for all operational parameters.

C. Submit manufacturer’s standard operation and maintenance information including installation manuals and safety instructions.

D. Submit contact list identifying names, addresses, telephone numbers, and any additional contact information for each equipment service organization involved with the Standby Engine/Generator Set.

E. Submit detailed operation and maintenance procedures for each major equipment item; include description of operation for all modes of operation, routine maintenance procedures, and trouble-shooting guide.

F. Submit listing spare parts provided under this contract and of recommended additional spare parts not provided under this contract along with costs, lead time, and supplier.

1.07 FACTORY TESTING

A. The generator set supplier shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided. Equipment supplied shall be fully tested at the factory for function and performance.

B. Factory testing may be witnessed by the owner and consulting engineer. Costs for travel expenses will be the responsibility of the owner and consulting engineer. Supplier is responsible to provide two weeks notice for testing.

C. Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.

1.08 QUALITY ASSURANCE

A. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

B. All materials, equipment, and parts shall be new and unused of current manufacture.

C. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

D. The Standby Engine/Generator Set manufacturer shall have been engaged in the manufacture of generator sets for a minimum of ten years and shall have a factory trained service and parts organization located within 100 miles of the jobsite.

E. All control equipment shall be the standard product of the engine/generator set manufacturer. Controls systems that are supplied by a subcontractor of the manufacturer and which are not incorporated into the standard documentation of the manufacturer will not be acceptable.

1.09 WARRANTY

A. The generator set and associated equipment shall be warranted for a period of not less than 5 years from the date of commissioning against defects in materials and workmanship.

B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

C. The manufacturer of the generator set shall maintain service parts inventory at a central location that is accessible to the service location 24 hours per day, 365 days per year.

D. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

E. The manufacturer shall maintain model and serial number records of each

generator set provided for at least 20 years.

1.010 EXTRA MATERIALS

A. Furnish supply of consumables (air cleaner, oil filter, etc.) in sufficient quantity to last for one year from the date of substantial completion.

1.011 DESIGN REQUIREMENTS (NOT USED)

1.012 MAINTENANCE

A. Before substantial completion, perform all maintenance activities required by any sections of the specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems into service.

PART 2 PRODUCTS AND MATERIALS

2.01 MANUFACTURER

A. Acceptable Manufacturers
   1. Cummins/Onan.
   2. Kohler Power Systems.

B. These specifications, installation design, the heating/ventilation design, and the fuel system design are based upon the first named manufacturer. If the contractor elects to supply a different manufacturer, then the contractor shall be responsible for adjusting the installation of the standby engine/generator set to satisfy the requirements of that manufacturer's equipment.

C. Alternate equipment will only be considered if the following information is submitted ten days prior to the bid date:
   1. Certified dimensional data.
   2. Verification of adequate cooling/combustion air for the installation.
   3. Complete interconnecting wiring and piping diagrams.
   4. Manufacturer's certification of prototype testing.
   5. Load study/profile showing non-overloading of genset under steady-state conditions and during motor starting.
   6. Manufacturer's product literature and performance data, sufficient to verify compliance to specification requirements.
   7. A paragraph-by-paragraph specification compliance statement, describing the differences between the specified and the proposed equipment.
   8. Short circuit study of the load circuits to verify that selective coordination occurs and that thermal-magnetic stresses on components will not exceed the specified ratings.
   9. Listing of similar projects and owner contact information for projects completed during the previous five years.

2.02 GENERATOR SET

A. Ratings

1. The generator set shall operate at 1800 rpm and at a voltage of: 120/208 Vots AC, Three-phase, Four-wire, 60 hertz.
2. The generator set shall have a minimum rating at 40 kW, 50 kVA at 0.8 PF, standby rating, based on site conditions of: Altitude 1000 feet, ambient temperatures up to 100 degrees F. Manufacturer shall be responsible for actual application performance.
3. The generator set rating shall be based on emergency/standby service.

B. Performance

1. Voltage regulation shall be plus or minus 1.0 percent for any constant load between no load and rated load for both parallel and non-parallel applications. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.
3. The engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
4. Motor starting capability shall be a minimum of 607 kVA. The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.
5. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic. Telephone influence factor shall be less than 40.
6. Generator shall be capable of starting and operating two 5 HP submersible sewerage pump(s) operated with SSRV and 3.3 kVA of misc. single phase load without causing interruption to any facility systems: IE control system, I&C Devices, access control system, etc. In addition, the generator shall be sized to star and run all miscellaneous loads as indentified herein.
    a. Step 1: 3.3 KVA of misc. control
    b. Step 2: (1) 5 HP submersible pump on RVSS
    c. Step 3: (1) 5 HP submersible pump on RVSS
7. Unit shall be sized for maximum starting voltage dip and peak voltage dip shall be less 10%.
8. Unit shall be sized for maximum frequency dip of 4%.

C. Construction

1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a corrosion resistant battery tray with hold-down clamps within the rails.

D. Engine-generator base and exterior panels along with applicable accessories shall contain a factory applied finish resistant to corrosion and effects from the unit operating temperature connections.

1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations for the number and type cables shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.
2. Power connections to auxiliary devices shall be made at the devices, with required protection located at the power distribution panel as shown on the drawings.
3. Generator set control interfaces to other system components shall be made on a common, permanently labeled terminal block assembly.

2.03 ENGINE AND ENGINE EQUIPMENT

A. The engine shall be natural gas fueled, radiator and fan cooled. Minimum displacement shall be 6.2L, with 8-cylinders. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories.

B. Engine accessories and features shall include:

1. Shall be Tier 3 compliant.
2. Complete engine fuel system, including all pressure regulators, strainers, and control valves. The fuel system shall be plumbed to the generator set skid for ease of site connections to the generator set.
3. An electronic governor system shall provide automatic isochronous frequency regulation.
4. Skid-mounted radiator and cooling system rated for full load operation in 104 degrees F (40 degrees C) ambient as measured at the generator air inlet, based on 0.5 inches H2O external static head. Radiator shall be sized based on a core temperature that is 20 degrees F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture. Rotating parts shall be guarded against accidental contact.
5. Electric starter(s) capable of three complete cranking cycles without overheating.
6. Positive displacement, mechanical, full pressure, lubrication oil pump.
7. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
8. Replaceable dry element air cleaner with restriction indicator.
9. Flexible supply and return fuel lines.
10. Engine mounted battery charging alternator, 40-ampere minimum, and solid-state voltage regulator.
11. Coolant heater

a. Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL 499 listed and labeled.

b. The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed using quick disconnect couplers to isolate the heater for replacement of the heater element. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.

c. The coolant heater shall be provided with a 24VDC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.

d. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 100F (40C) in a 40F ambient, in compliance with NFPA 110 requirements, or the temperature required for starting and load pickup requirements of this specification.

12. Provide vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.

13. Starting and Control Batteries shall be calcium/lead antimony type, 24 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors.

C. Battery Charger

1. Shall be ATS mounted and connect to skid.

2.04 AC GENERATOR

A. The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single pre-lubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 125 degrees Centigrade.

B. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.

C. A permanent magnet generator (PMG) shall be included to provide a reliable

source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single-phase or three-phase fault at approximately 300% of rated current for not more than 10 seconds.

D. The subtransient reactance of the alternator shall not exceed 12 percent, based on the standby rating of the generator set.

2.05 ENGINE GENERATOR SET CONTROL

A. A NEMA 1/3R/4 enclosed control panel shall be mounted on the generator set with vibration isolators. The control shall be vibration isolated and prototype tested to verify the durability of all components under the vibration conditions encountered.

B. The generator set mounted control shall include the following features and functions:

1. Three-position control switch labeled RUN/OFF/AUTO. In the RUN position the generator set shall automatically start, and accelerate to rated speed and voltage. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
2. RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
3. PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power.
4. Generator Set AC Output Metering: The generator set shall be provided with a metering set with the following features and functions:
   a. Analog AC Voltmeter, dual range, 90 degree scale, 2% accuracy; Analog AC Ammeter, dual range, 90 degree scale, 2% accuracy; Analog Frequency/RPM meter, 45-65 Hz, 1350-1950 RPM, 90 degree scale, +/- 0.6 Hz accuracy.
   b. Seven position phase selector switch with OFF position to allow meter display of current and voltage in each generator phase. When supplied with reconnectable generators, the meter panel shall be reconnectable for the voltage specified.
5. Generator Set Alarm and Status Display: The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing alarm and shutdown conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on the display panel:

a. Low oil pressure (alarm).
b. Low oil pressure (shutdown).
c. Low coolant temperature (alarm).
d. High coolant temperature (alarm).
e. High coolant temperature (shutdown).
f. Overcrank (shutdown).
g. Overspeed (shutdown).
h. Low fuel (alarm).
i. In addition, provisions shall be made for indication of two customer-specified alarm or shutdown conditions.

6. Engine Status Monitoring: The following devices shall be provided on the generator set control:
   a. Engine oil pressure gauge.
   b. Engine coolant temperature gauge.
   c. Engine operation hour gauge.
   d. Battery voltage (DC volts).
7. Engine Control Functions. The control system provided shall include a cycle cranking system, which shall be for 3 cranking periods of 15 seconds each, with 15 second rest period between cranking periods. Fail to start shall be indicated by operation of the overcrank alarm indication lamp. The control system shall also include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification.
8. Alternator Control Functions:
   a. The generator set shall include an automatic voltage regulation system that is matched and prototype tested with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse-width modulated output to the alternator exciter. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ.
   b. Voltage adjusting rheostat, locking screwdriver type, to adjust voltage +/- 5% from rated value.
9. Control Interfaces for Remote Monitoring. Provide the following features in the control system:
   a. Form "C" dry common alarm contact set rated 2A @ 30VDC to indicate existence of any alarm or shutdown condition on the generator set.
   b. One set of contacts rated 2A @ 30VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.
   c. A fused 10 amp switched 12VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.
   d. A fused 20 amp 12VDC power supply circuit shall be provided for

customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.

10. The generator set shall be provided with a mounted main line circuit breaker, sized to carry the rated output current of the generator set on a continuous basis as shown on the drawings. Circuit breaker shall be equipped with shunt trip and shall automatically open on a genset shutdown alarm.

C. Sequence of Operation

1. Generator set shall start on receipt of a start signal from remote equipment.
2. The generator set control shall initiate the starting sequence for the generator set.
3. The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.
4. When all start signals have been removed from the generator set, the generator set control shall switch off the excitation system and shall shut down.
5. Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

2.06 ENGINE EXHAUST SYSTEM

A. Provide exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards.

B. Provide stainless steel, seamless flexible exhaust manifold connector.

C. Silencer and exhaust piping shall be insulated with rigid insulation to maintain a surface temperature of not more than 150 degrees F. Provide 0.016-inch aluminum jacket complete with crimped end covers, secured with stainless steel sheet metal screws and rubber coated washers. Insulation system shall not interfere with flexible fittings.

D. Provide exhaust thimble(s) for exhaust penetration of walls constructed of combustible material. Construction shall be fireproof.

2.07 OUTDOOR WEATHER-PROTECTIVE SOUND ATTENUATING HOUSING

A. The generator set shall be provided with a sound-attenuated housing which allows the generator set to operate at full rated load in the ambient conditions previously specified. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of 65 dBA at 23 ft from the generator set in a free field environment. Housing configuration and materials used may be of any suitable design which meets application needs, except that acoustical materials used shall be oil and water resistant. No foam materials shall be used unless they can be demonstrated to have the same durability and life as fiberglass.

B. The enclosure shall include hinged doors for access to both sides of the engine and alternator, and the control equipment. Key-locking and pad-lockable door latches shall be provided for all doors. Door hinges shall be stainless steel.

C. The enclosure shall be provided with an exhaust silencer that is mounted inside of the enclosure, and allows the generator set package to meet specified sound level requirements. Silencer and exhaust shall include a rain cap and rain shield.

D. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturer's standard color. All surfaces of all metal parts shall be primed and painted.

E. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.

2.08 ACCESSORIES

A. Provide supply of consumables (air cleaner, oil filter, etc) in sufficient quantity to last for one year from the date of substantial completion.

B. Provide trouble shooting light inside enclosure.

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK

A. The Contractor shall have overall system responsibility and shall provide all materials and labor necessary provide a complete and operable system and comply with all requirements of this section.

B. The engine/generator set manufacturer shall be responsible for certifying the correctness of installation for all work related to the standby power system regardless of who performs the installation work.

C. The contract drawings are diagrammatic in nature; it shall be the responsibility of the manufacturer to supplement the contract drawings and complete the final design of the standby power system and to coordinate exact requirements with the

installing contractors.

3.02 FIELD MEASUREMENTS

A. Field verify with exact measurements, the available mounting space for standby power system equipment. Do not base electrical installation or equipment locations on the contract drawings. Actual field conditions govern all final installed locations, distances, and levels.

B. Identify conflicts prior to beginning installation of the engine generator system.

3.03 DELIVERY STORAGE AND HANDLING

A. It shall be the responsibility of the installing contractor to receive all standby power system equipment at the job site. Carefully inspect all equipment for damage prior to accepting from the shipping agency. Do not accept shipment if damage is evident.

B. Exercise due diligence in storing, protecting, and moving standby power system equipment. Damaged or worn equipment will not be accepted and will be replaced at no additional cost to the Owner.

3.04 INSTALLATION

A. Install equipment in locations as indicated on the contract documents. Adjust locations as needed to ensure operability, serviceability, and compliance with all applicable codes and standards.

B. Installation shall be completely tested prior to start-up. This work includes verification of all field wiring continuity and proper termination of wiring.

C. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

D. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

E. Installation of equipment shall include furnishing and installing all fuel piping and vent piping as required. The tank installer shall perform this work under the supervision of the equipment supplier.

F. Equipment shall be installed on concrete housekeeping pads. Equipment shall be

permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.

G. Equipment shall be initially started and operated by representatives of the manufacturer.

H. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.

3.05 TESTING AND START-UP SERVICES

A. Standby power system supplier shall provide installation and start-up services required to place the complete system into operation.

B. The complete installation shall be tested for compliance with the specification following completion of all site work. Representatives of the manufacturer shall conduct testing, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests.

C. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two-hour full load test, and a one step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test. Provide all required cables and make accommodations for routing of cables to allow for load bank to be located outside of the building.

D. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

E. Test alarm and shutdown circuits by simulating conditions. Adjust output voltage and engine speed.

F. Record kW, Amps, Volts, Frequency, oil pressure, coolant temperature, and room temperature at twenty-minute intervals during the test and report findings to Engineer in writing.

G. Verify operation of room ventilation system including interlocks with generator equipment.

H. Verify fuel system installation and capacity.

3.06 TRAINING

A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training

program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.

B. Describe the loads connected to the standby power system along with restrictions for future use. Coordinate this discussion with the process instrumentation control system integrator to include automatic step start control and load control.

END OF SECTION

SECTION 26 36 23

TRANSFER SWITCH

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. Applicable provisions of Part I shall govern the work of this section.

B. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
    a. NFPA20 – Fire Pumps. Transfer switches serving fire pumps shall be specifically listed and labeled for that application.
    b. NFPA70 – National Electrical Code, (NEC) and state amendments thereto. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
    c. NFPA99 – Essential Electrical Systems for Health Care Facilities.
    d. NFPA110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE), Specifications and Standards, current edition.
    a. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
4. Insulated Cable Engineers Association (ICEA)
5. International Society of Automation (ISA)
6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition.
    a. NEMA ICS10-1993 – AC Automatic Transfer Switches.
7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
    a. UL 1008. The transfer switch shall be UL listed and labeled.
8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), current edition.

a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.

10. International Electrical Testing Association (NETA)
11. Canadian Standards Association (CSA), Specifications and Standards, current edition.
    a. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
    b. CSA 282, 1989 Emergency Electrical Power Supply for Buildings.
12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
13. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.
    a. IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity.
    b. IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity.
    c. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity.
    d. IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity. Similar waveforms are described in ANSI/IEEE 62.41-1991.
    e. IEC 1000-4-6 Conducted Field Immunity.
    f. IEC 1000-4-11 Voltage Dip Immunity.
14. European Committee for Electrotechnical Standardization (CENELEC), Specifications and Standards, current edition:
    a. EN55011, Class B Radiated Emissions.
    b. EN55011, Class B Conducted Emissions.

1.03 DESCRIPTION OF WORK

A. Provide complete factory assembled power transfer equipment with field programmable digital electronic controls designed for fully automatic operation and including: surge voltage isolation, voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts for both sources.

B. Provide factory test, startup by a supplier authorized by the manufacturer, and on-site testing of the system. Technicians specifically trained to support the product and employed by the generator set supplier shall service the transfer switches.

C. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility for all the products provided.

D. The automatic transfer switch specified herein shall be equipped with a time delay in the neutral position (programmed transition). Alternative methods for transfer control are not acceptable.

E. The ATS provide shall be manufactured and supplied by the same Manufacture of the Engine generator set.

F. Provide ATS as NEMA1 enclosure.

G. The automatic transfer switch specified herein shall be equipped with a time delay in the neutral position (programmed transition). Alternative methods for transfer control are not acceptable.

H. Provide ATS as shown.

1.04 RELATED WORK ELSEWHERE

A. For the purpose of obtaining a complete and integrated standby power system, the following sections shall be included under the scope of this section:
   1. Section 26 32 13 – Standby Engine/Generator Set.

B. The following sections include work which is related to the Standby Engine/Generator Set, but which is not included under the scope of this section:

C. Article 102 – Bidding Requirements and Conditions

D. Article 103 – Award and Execution of the Contract

E. Concrete – Division 03

F. Metals – Division 05

G. Electrical - Division 26

1.05 SUBMITTALS

A. Submit shop drawings as specified herein.

B. General requirements specific to this section include:
   1. Submit complete and integrated document containing all equipment included under the scope of this section as part of the submittal document for the Standby Engine/Generator Set.
   2. Submittal shall be complete, neat, orderly, and indexed with tabbed dividers. Partial submittals will not be accepted.
   3. Clarity and completeness are of prime importance. Acceptability of submittal drawings shall be at the sole discretion of the Engineer in regards to this requirement.
   4. Additional requirements for the various subsystems are specified in the corresponding sections.

C. Submit the following information:
   1. Manufacturer's product literature and performance data, sufficient to verify compliance to specification requirements.
   2. A paragraph-by-paragraph specification compliance statement, describing the differences between the specified and the proposed equipment.
   3. Manufacturers published warranty documents signed by an officer of the company.

4. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
5. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
6. Manufacturer's installation instructions.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit Operation/Maintenance Manuals and Instructions as specified herein.

B. Submit final revised shop drawings incorporating any modifications made as a result of installation, start-up, operational testing, or for any other cause. Submit results of all field-testing and corrective actions taken for all operational parameters.

C. Submit manufacturer’s standard operation & maintenance information including installation manuals and safety instructions.

D. Submit contact list identifying names, addresses, telephone numbers, and any additional contact information for each equipment service organization involved with the Standby Engine/Generator Set.

E. Submit detailed operation and maintenance procedures for each major equipment item; include description of operation for all modes of operation, routine maintenance procedures, and trouble-shooting guide.

F. Submit listing spare parts provided under this contract and of recommended additional spare parts not provided under this contract along with lead time and costs.

1.07 FACTORY TESTING

A. The generator set supplier shall perform a complete operational test on the automatic transfer switch prior to shipping from the factory. A certified test report shall be provided. Equipment supplied shall be fully tested at the factory for function and performance.

B. Factory testing may be witnessed by the owner and consulting engineer. Costs for travel expenses will be the responsibility of the owner and consulting engineer. Supplier is responsible to provide two weeks notice for testing.

C. Test process shall include calibration of voltage sensors.

1.08 QUALITY ASSURANCE

A. The Automatic Transfer Switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying

quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

B. All materials, equipment, and parts shall be new and unused of current manufacture.

C. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

D. The Automatic Transfer Switch manufacturer shall have been engaged in the manufacture of generator sets for a minimum of ten years and shall have a factory trained service and parts organization located within 100 miles of the jobsite.

E. All control equipment shall be the standard product of the engine/generator set manufacturer. Controls systems that are supplied by a subcontractor of the manufacturer and which are not incorporated into the standard documentation of the manufacturer will not be acceptable.

1.09 WARRANTY

A. The generator set and associated equipment shall be warranted for a period of not less than five years from the date of commissioning against defects in materials and workmanship.

B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

C. The manufacturer of the transfer switch shall maintain service parts inventory at a central location that is accessible to the service location twenty-four hours per day, three hundred sixty-five days per year.

D. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

E. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least twenty years.

1.10 EXTRA MATERIALS (NOT USED)

1.11 DESIGN REQUIREMENTS (NOT USED)

1.12 MAINTENANCE

A. Before substantial completion, perform all maintenance activities required by any sections of the specifications including any calibrations, final adjustments,

component replacements or other routine service required before placing equipment or systems into service.

PART 2 PRODUCTS AND MATERIALS

2.01 MANUFACTURER

A. Acceptable Manufacturers
   1. Cummins/Onan.
   2. Kohler Power Systems.

B. The automatic transfer switch shall be provided as part of a complete, integrated standby power system. As such, the manufacturer of the Standby Engine/Generator Set shall provide it.

2.02 POWER TRANSFER SWITCH

A. Ratings
   1. Refer to the project drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings, enclosure type, and accessories.
   2. Main contacts shall be rated for 600 Volts AC, minimum.
   3. Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C, relative humidity up to 95 percent (non-condensing), and altitudes up to 10,000 feet (3000M).
   4. Transfer switch equipment shall have with stand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents shown on the drawings and at the specified voltage. The transfer switch and its upstream protection shall be coordinated. The transfer switch shall be third party listed and labeled for use with the specific protective device(s) installed in the application.

B. Construction
   1. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the source 1 and source 2 positions. The transfer switch shall be specifically designed to transfer to the best available source if it inadvertently stops in a neutral position.
   2. Transfer switches rated through 1000 amperes shall be equipped with permanently attached manual operating handles and quick break, quick make over center contact mechanisms. Transfer switches over 1000 amperes shall be equipped with manual operators for service use only under de energized conditions. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.
   3. Transfer switch internal wiring shall be composed of pre-manufactured

harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism.

4. Power transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with components that could be operating at line voltage levels.
5. Transfer switches designated as 4-pole switches on the drawings shall be provided with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar. Substitute equipment using overlapping neutral contacts is not acceptable.
6. Transfer switches designated as 3-pole switches on the drawings shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100 percent of the current designated on the switch rating.

C. Connections

1. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.
2. Transfer switch shall be provided with AL/CU mechanical lugs sized to accept the full output rating of the switch. Lugs shall be suitable for the number and size of conductors shown on the drawings.

2.03 TRANSFER SWITCH CONTROL

A. Operator Panel. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be a sealed membrane panel rated NEMA 3R/IP53 or better (regardless of enclosure rating) that is permanently labeled for switch and control functions.

B. Operator panel and features and capabilities shall include:

1. High intensity LED lamps to indicate the source that the load is connected to (source 1 or source 2); and which source(s) are available. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control.
2. High intensity LED lamps to indicate that the transfer switch is “not in auto” (due to control being disabled or due to bypass switch (when used) enabled or in operation) and “Test/Exercise Active” to indicate that the control system is testing or exercising the generator set.
3. “OVERRIDE” pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation.
4. “TEST” pushbutton to initiate a preprogrammed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test with load or test without load.

5. "RESET/LAMP TEST" pushbutton that will clear any faults present in the control, or simultaneously test all lamps on the panel by lighting them.
6. The control system shall continuously log information on the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. This information shall be available via a PC-based service tool or an operator display panel.
7. Security Key Switch to allow the user to inhibit adjustments, manual operation or testing of the transfer switch unless key is in place and operated.
8. Vacuum fluorescent alphanumeric display panel with push-button navigation switches. The display shall be clearly visible in both bright (sunlight) and no light conditions. It shall be visible over an angle of at least 120 degrees. The Alphanumeric display panel shall be capable of providing the following functions and capabilities:
    a. Display source condition information, including AC voltage for each phase of normal and emergency source, frequency of each source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance.
    b. Display source status, to indicate source is connected or not connected.
    c. Display load data, including 3-phase AC voltage, 3-phase AC current, frequency, KW, KVA, and power factor. Voltage and current data for all phases shall be displayed on a single screen.
    d. The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:
        1) Set nominal voltage and frequency for the transfer switch.
        2) Adjust voltage and frequency sensor operation set points.
        3) Set up time clock functions.
        4) Set up load sequence functions.
        5) Enable or disable control functions in the transfer switch, including program transition.
        6) Set up exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and retransfer.
    e. Display Real time Clock data, including date, and time in hours, minutes, and seconds. The real time clock shall incorporate provisions for automatic daylight savings time and leap year adjustments. The control shall also log total operating hours for the control system.
    f. Display service history for the transfer switch. Display source connected hours, to indicate the total number of hours connected to each source. Display number of times transferred, and total number of times each source has failed.
    g. Display information for other transfer switches in the system,

including transfer switch name, real time load in KW on the transfer switch, current source condition, and current operating mode.

h. Display fault history on the transfer switch, including condition, and date and time of fault. Faults to include controller checksum error, low controller DC voltage, ATS fail to close on transfer, ATS fail to close on retransfer, battery charger malfunction, network battery voltage low, network communications error.

C. Internal Controls

1. The transfer switch control system shall be field-configurable for any operating voltage level up to 600VAC. Provide RMS voltage sensing and metering that is accurate to within +/-1 percent of nominal voltage level. Frequency sensing shall be accurate to within +/-0.2 percent. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field-configurable are not acceptable.

2. Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:

a. Monitoring all phases of the normal service (source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98 percent of the normal voltage level and dropout in a range of 75 to 98 percent of normal voltage level).

b. Monitoring all phases of the emergency service (source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98 percent of the normal voltage level and dropout in a range of 75 to 98 percent of pickup voltage level).

c. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance.

d. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for loss of a single phase.

e. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for phase rotation.

f. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for overvoltage conditions (adjustable for dropout over a range of 105 to 135 percent of normal voltage, and pickup at 95-99 percent of dropout voltage level).

g. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over or under frequency conditions.

h. Monitoring the neutral current flow in the load side of the transfer switch. The control shall initiate an alarm when the neutral current exceeds a preset adjustable value in the range of 100-150 percent of rated phase current for more than an adjustable period of 10 to 60 seconds.

3. All transfer switch sensing shall be configurable from a Windows 95, 98, 2000, or NT PC-based service tool, to allow setting of levels, and enabling or disabling of features and functions. Selected functions including voltage sensing levels and time delays shall be configurable using the operator panel. Designs utilizing DIP switches or other electromechanical devices are not acceptable. The transfer control shall incorporate a series of diagnostic LED lamps.
4. The transfer switch shall be configurable to control the operation time from source to source (program transition operation). The control system shall be capable of enabling or disabling this feature, and adjusting the time period to a specific value. A phase band monitor or similar device is not an acceptable alternate for this feature.
5. The transfer switch shall incorporate adjustable time delays for generator set start (adjustable in a range from 0-15 seconds); transfer (adjustable in a range from 0-120 seconds); retransfer (adjustable in a range from 0-30 minutes); and generator stop (cool down) (adjustable in a range of 0-30 minutes).
6. The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device to prevent transfer to the generator service.
7. The transfer switch shall provide a relay contact signal prior to transfer or retransfer. The time period before and after transfer shall be adjustable in a range of 0 to 50 seconds.
8. The control system shall be designed and prototype tested for operation in ambient temperatures from -40C to +70C. It shall be designed and tested to comply with the requirements of the noted voltage and RFI/EMI standards.
9. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.

D. Battery Charger

1. The transfer switch shall be provided with a battery charger for the generator set starting batteries. The battery charger shall be a float type charger rated 2 amps. The battery charger shall include an ammeter for display of charging current and shall have fused AC inputs and DC outputs.
2. Provide the transfer switch with a battery charger for the generator set starting batteries. The battery charger shall be a float type charger rated 6 amps minimum. The battery charger shall include an ammeter for display of charging current and shall have fused AC inputs and DC outputs. The charger shall also include fault indications for high and low dc voltage, and supply power failed, and dry contacts for external indication of these fault conditions. Display supply power failed indication on the ATS control panel.

E. Control Interface

1. The transfer switch will provide an isolated relay contact for starting of a generator set. The relay shall be normally held open, and close to start the generator set. Output contacts shall be form C, for compatibility with any generator set.
2. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.
3. The transfer switch shall provide relay contacts to indicate the following conditions: source 1 available, load connected to source 1, source 2 available, source 2 connected to load.

2.04 ENCLOSURE

A. Enclosures shall be UL listed. The enclosure shall provide wire bend space in compliance to the latest version of NFPA 70. The cabinet door shall include permanently mounted key type latches.

B. Transfer switch equipment shall be provided in a NEMA 4X stainless steel enclosure.

C. Enclosures shall be the NEMA type specified. The cabinet shall provide code-required wire bend space at point of entry as shown on the drawings. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles and/or non-key-operated control switches located on outside of cabinet do not meet this specification and are not acceptable.

2.05 OPERATION

A. Sequence of Operation
1. Transfer switch normally connects an energized utility power source (source 1) to loads and a generator set (source 2) to the loads when normal source fails. The normal position of the transfer switch is source 1 (connected to the utility), and no start signal is supplied to the genset.
2. Generator Set Exercise (Test) With Load Mode. The control system shall be configurable to test the generator set under load. In this mode, the transfer switch shall control the generator set in the following sequence:
   a. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
   b. The transfer switch shall issue a compatible start command to the generator set and cause the generator set to start and run at idle until it has reached normal operating temperature.
   c. When the generator set has reached normal operating temperature or after an adjustable time period (whichever is shorter), the control system shall adjust the generator set output to rated voltage and frequency.

d. When the control systems senses the generator set at rated voltage and frequency, it shall operate to connect the loads to the generator set by opening the normal source contacts, and closing the alternate source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.

e. The generator set shall operate connected to the load for the duration of the exercise period. If the generator set fails during this period, the transfer switch shall automatically reconnect the generator set to the normal service.

f. On completion of the exercise period, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.

g. The transfer switch shall operate the generator set unloaded for a cool down period, and then remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

3. Generator Set Exercise (Test) Without Load Mode. The control system shall be configurable to test the generator set without transfer switch load connected. In this mode, the transfer switch shall control the generator set in the following sequence:

a. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.

b. The transfer switch shall issue a compatible start command to the generator set and cause the generator set to start and run at idle until it has reached normal operating temperature.

c. When the generator set has reached normal operating temperature or after an adjustable time period (whichever is shorter), the control system shall accelerate the generator set to rated voltage and frequency.

d. When the control systems senses the generator set at rated voltage and frequency, it shall operate the generator set unloaded for the duration of the exercise period.

e. At the completion of the exercise period, the transfer switch shall remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK

A. The Contractor shall have overall system responsibility and shall provide all materials and labor necessary provide a complete and operable system and comply with all requirements of this section.

B. The engine/generator set manufacturer shall be responsible for certifying the correctness of installation for all work related to the standby power system regardless of who performs the installation work.

C. The contract drawings are diagrammatic in nature; it shall be the responsibility of the manufacturer to supplement the contract drawings and complete the final design of the standby power system and to coordinate exact requirements with the installing contractors.

3.02 FIELD MEASUREMENTS

A. Field verify with exact measurements, the available mounting space for standby power system equipment. Do not base electrical installation or equipment locations on the contract drawings. Actual field conditions govern all final installed locations, distances, and levels.

B. Identify conflicts prior to beginning installation.

3.03 DELIVERY STORAGE AND HANDLING

A. It shall be the responsibility of the installing contractor to receive all standby power system equipment at the job site. Carefully inspect all equipment for damage prior to accepting from the shipping agency. Do not accept shipment if damage is evident.

B. Exercise due diligence in storing, protecting, and moving standby power system equipment. Damaged or worn equipment will not be accepted and will be replaced at no additional cost to the Owner.

3.04 INSTALLATION

A. Install equipment in locations as indicated on the contract documents. Adjust locations as needed to ensure operability, serviceability, and compliance with all applicable codes and standards.

B. Installation shall be completely tested prior to start-up. This work includes verification of all field wiring continuity and proper termination of wiring.

C. The contractor shall install the equipment in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

D. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

E. Equipment shall be initially started and operated by representatives of the manufacturer.

F. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.

3.05 TESTING AND START-UP SERVICES

A. Standby power system supplier shall provide installation and start-up services required to place the complete system into operation.

B. The complete installation shall be tested for compliance with the specification following completion of all site work. Representatives of the manufacturer shall conduct testing, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests.

C. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two-hour full load test, and a one step rated load pickup test in accordance with NFPA 110.

D. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

E. Test all control functions by simulating conditions.

F. Provide for one technician follow-up visit to installation site one month after commissioning to consult with Owner, verify correct operation of standby system, and make any required corrections, adjustments, repairs, etc.

3.06 TRAINING

A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided as part of the owner training session specified under Standby Engine Generator Set.

END OF SECTION

SECTION 26 43 13

SURGE PROTECTIVE DEVICES (SPDs)

LOW VOLTAGE AC SURGE PROTECTION FOR ELECTRICAL DISTRIBUTION SYSTEMS

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. Applicable provisions of Part I shall govern the work of this section.

B. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
   a. ANSI/NFPA 70 - National Electrical Code (NEC) and state amendments thereto.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. International Society of Automation (ISA)
6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition.
7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), current edition.
   a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
10. International Electrical Testing Association (NETA)
11. Canadian Standards Association (CSA), Specifications and Standards, current edition.
12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
13. International Electrotechnical Association (IEC), Specifications and

Standards, Current Edition.

1.03 DESCRIPTION OF WORK

A. For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of:
   1. Section 26 90 00 - Process Instrumentation & Control

B. Furnish and install complete and operable power system as indicated on the drawings and as specified herein.

C. The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the contract drawings. To maximize performance and reliability and to obtain the lowest possible let-through voltages, the ac surge protection shall be integrated into electrical distribution equipment such as switchgear, switchboards, panelboards, busway (integrated within bus plug), or motor control centers.

1.04 RELATED SECTIONS

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

1.05 SUBMITTALS

A. Submit shop drawings as specified herein.

B. The following information shall be submitted specifically for surge protection devices:
   1. Manufacturer literature sufficient in scope to demonstrate compliance with the requirements of this specification.
   2. Verification that the SPD complies with the required ANSI/UL 1449 3rd Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage,

phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (I_n).

3. For sidemount mounting applications (SPD mounted external to electrical assembly), electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation & maintenance manuals and instructions as specified herein.

1.07 FACTORY TESTING (NOT USED)

1.08 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

C. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

D. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

E. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

1.09 MAINTENANCE

A. Before substantial completion, perform all maintenance activities required by any sections of the specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems into service.

PART 2 PRODUCTS AND MATERIALS

2.01 MANUFACTURERS

A. Allen Bradley 1483-DSx

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in

their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

2.02 VOLTAGE SURGE SUPPRESSION – GENERAL

A. AC surge protection device UL 1449

B. Voltage: Match system system

C. Provide protection for all 3 phase plus the neutral

D. Provide 40KA current rating

E. Provide fused disconnect for SPD.

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK

3.02 FIELD MEASUREMENTS

A. Field verify all measurements. Do not base exact SPD installation locations on the contract drawings. Actual field conditions govern all final installed locations, distances, and levels.

B. Identify conflicts with the work of other trades prior to installation of electrical equipment.

3.03 DELIVERY, STORAGE, AND HANDLING

A. Accept SPD's on site. Inspect for damage.

B. Protect SPD's from corrosion and entrance of debris.

C. Store SPD's above grade. Protect from environment with suitable covering.

3.04 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's recommendations and the contract drawings.

3.05 TESTING AND START-UP SERVICES

A. Refer to the requirements of Section 26 08 00 - Commissioning of Electrical Systems

3.06 TRAINING

A. Refer to the requirements of Section 26 08 00 - Commissioning of Electrical Systems
   1. .

END OF SECTION

SECTION 26 90 00

PROCESS INSTRUMENTATION AND CONTROL

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
    a. ANSI/NFPA 70 - National Electrical Code (NEC) and state amendments thereto.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. International Society of Automation (ISA), Specifications and Standards, current edition:
    a. ANSI/ISA-5.1-1984 - Instrumentation Symbols and Identification.
    b. ANSI/ISA-5.3-1983 - Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.
    c. ANSI/ISA-95.00.01-2000 - Enterprise Control System Integration, Part 1: Models and Terminology.
    d. ANSI/ISA-TR99.00.01-2004, Security Technologies for Manufacturing and Control Systems.
    e. ANSI/ISA-TR99.00.02-2004, Integrating Electronic Security into the Manufacturing and Control Systems Environment.
6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition:
    a. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
    b. NEMA ICS 3 - Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC.

7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
    a. UL508 - Industrial Control Equipment.
    b. UL508A - Industrial Control Panels.
    c. UL 913 - Intrinsically Safe Specification.
    d. UL94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), current edition.
    a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
10. International Electrical Testing Association (NETA)
    a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
11. Canadian Standards Association (CSA), Specifications and Standards, current edition.
    a. CSA C22.2, Industrial Control Equipment.
12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
13. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.
    a. IEC 60529 - Classification of Degrees of Protection Provided by Enclosures14. CE - European Community, Applicable Directives.
        1) EN50005 - for Terminal Markings.
        2) EN50081-1- Generic Emission Standard.
        3) EN50082-1 - Generic Immunity Standard.
        4) EN61000-4-4 - Electromagnetic compatibility (EMC). Testing and measurement techniques.
        5) EN61000-4-5 - Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test.

1.03 DESCRIPTION OF WORK

A. For the purpose of obtaining a complete and integrated Process Instrumentation and Control System, the following sections shall be included under the scope of this section:
    1. Section 26 29 13 - Motor Controllers
    2. Section 26 90 10 - Control Panel Construction
    3. Section 26 90 11 - Control Panel Components
    4. Section 26 90 20 - Instrumentation Devices
    5. Section 26 90 30 - Programmable Logic Controllers
    6. Section 26 90 60 - Ethernet Networking Equipment

B. The work specified herein shall include the furnishing of all materials, equipment, labor, and supervision necessary to fabricate, install, start-up, and test a complete and operable Process Instrumentation and Control System.

C. The labor specified herein includes but is not limited to engineering, software development, panel fabrication, equipment calibration and adjustment, testing, training, and documentation.

D. This section identifies the overall functional requirements for the Process Instrumentation and Control System.

E. This section includes coordination with the work of other sections. This work includes identification of exact interface requirements with motors, control panels, and field instrumentation provided under other portions of this specification. It shall be the responsibility of the system integrator specified under this section to execute this coordination during the shop drawing submittal phase of the work. Additional costs due to inadequate coordination as required herein shall be borne solely by this contractor.

F. This section includes coordination with electrical contractor to ensure that the proper number of raceways and conductors are installed. It shall be the responsibility of the system integrator to coordinate this work with the installing electrician. Additional costs due to inadequate coordination as required herein shall be borne solely by this contractor.

G. Provide complete design and installation of a complete and operable pump station as shown and described. System shall utilize a duplex pump station to control the wetwell level via hardwired float control. Status of the station shall be monitored via radio telemetry back at the master SCADA system.

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

1.05 SUBMITTALS

A. Submit shop drawings as specified herein.

B. Submit the following information specifically relating to process instrumentation and control:

1. General requirements specific to this section include:
   a. Submit complete and integrated document containing all equipment included under the scope of this section.
   b. Submittal shall be complete, neat, orderly, and indexed with tabbed dividers. Partial submittals will not be accepted.
   c. Include a complete list of proposed exceptions to and deviations from these specifications.
   d. Clarity and completeness are of prime importance. Acceptability of submittal drawings shall be at the sole discretion of the Engineer in regards to this requirement.
   e. Additional requirements for the various subsystems are specified in the corresponding sections.
2. Submit the following information:
   a. Bill of Materials:
      1) Complete listing of all components identifying exact make and model, quantity, and description.
   b. Component Data Sheets:
      1) Detailed listing for each type of device, identifying Engineer's tag number, manufacturer, model, options, ranges, and other information necessary to supplement component catalog cut sheets and clearly show compliance with these specifications.
   c. Component Catalog Cut sheets:
      1) Manufacturer's standard catalog information.
   d. Control Panel Construction Drawings:
      1) Scaled drawings of all control panels and enclosures.
      2) Front panel elevation complete with nameplate legend.
      3) Back panel elevation complete with schedule of devices.
   e. Control Panel Schematic Wiring Diagrams:
      1) Ladder type schematic diagrams.
      2) Show all devices requiring electrical connections.
      3) Identify all wire and terminal numbers.
      4) Identify PLC I/O addresses.
      5) Reference Engineer's tag number where assigned.
      6) Cross-reference all relay contacts and coils.
      7) Identify switching action on all switching devices.
      8) Common diagrams will not be accepted.
   f. Analog Loop Diagrams:
      1) Show all devices requiring electrical connections.
      2) Identify all wire and terminal numbers.
      3) Identify PLC I/O addresses.
      4) Identify location of loop power supply.

5) Identify field devices, back-of-panel devices, and front-of panel devices.
6) Show tabular summary of transmitter output capability, input impedance of each receiver, total loop impedance, and reserve output capacity.
7) Reference Engineer's tag number where assigned.
8) Common diagrams will not be accepted.

g. Control Panel Plumbing Diagrams:
1) Show all devices requiring plumbing connections (air or liquid).
2) Show pipe/tube sizing.
3) Show all control devices (valves, regulators, filters, etc.).

h. Control Panel Power and Environmental Requirements:
1) Identify voltage and ampacity requirements.
2) Show sizing calculations for environmental controls (ventilation, heat, air conditioning).

i. Interconnecting Wiring Diagrams:
1) Show all interconnections between control panels.
2) Show all interconnections between control panels and motor control centers.
3) Show all interconnections between control panels and field devices.
4) Show all interconnections between motor control centers and field devices.
5) Identify all wire and terminal numbers, including field terminal junction box terminals.

j. Control Device Installation Details:
1) Supplement contract documents with additional details necessary for proper installation of control devices.

k. Configuration Documentation:
1) Submit complete, documented configuration data for all configurable controllers.
2) Additional requirements for PLC systems and PC based SCADA systems are identified in the individual subsystem sections.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation & maintenance manuals and instructions as specified herein.

B. Submit the following information specifically for hardware alarm notification system:
1. Submit final revised shop drawings incorporating any modifications made as a result of factory test, installation, start-up, operational testing, or for any other cause. Submit results of all field-testing and corrective actions

taken for all discrete control devices and for all analog control devices. Submit analog device calibration data sheets.

2. Submit manufacturers standard operation & maintenance information including installation manuals and safety instructions.
3. Submit contact list identifying names, addresses, telephone numbers, and any additional contact information for each equipment service organization involved with the Process Instrumentation and Control System.
4. Submit detailed operation and maintenance procedures for each major equipment item; include description of operation for all modes of operation, routine maintenance procedures, and trouble-shooting guide.
5. Submit listing spare parts provided under this contract and of recommended additional spare parts not provided under this contract along with costs.

1.07 FACTORY TESTING

A. The entire Process Instrumentation and Control System shall be assembled at the manufacturer's facility and tested to the greatest extent possible. This test shall include simulation of all I/O points, simulation of system alarms, and demonstration of proper system operation. Document the results of this test in writing and submit to the Engineer.

B. The Engineer and Owner may witness the factory acceptance test. Schedule test date a minimum of two weeks in advance to allow attendance by the Engineer and the Owner.

C. Correct any deficiencies identified during the test prior to shipping the control system to the job site.

1.08 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.09 WARRANTY

A. See Division 01 for additional requirements.

1.10 EXTRA MATERIALS (NOT USED)

1.11 DESIGN REQUIREMENTS (NOT USED)

1.12 MAINTENANCE

A. Before substantial completion, perform all maintenance activities required by any sections of the specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems into service.

B. Furnish all spare parts as required by other sections of the specifications.

PART 2 PRODUCTS AND MATERIALS

2.01 SYSTEM INTEGRATOR

A. The system integrator shall be a firm specializing in the integration of control systems with documented experience in the detailed design, construction, configuration, and maintenance of PLC based control systems and motor control centers for the water/wastewater utility market. This experience must include a minimum of five projects similar in nature to this project during the last five years.

B. Acceptable system integrators include
   1. Altronex Control Systems, a division of LW Allen, Madison, WI
   2. Or Equal

2.02 GENERAL FUNCTIONAL DESCRIPTION

A. Summary of System Improvements:
   1. New PLC based control systems shall be provided for the James St Pump Station:
      a. New pump station control panel shall consist of an Allen-Bradley CompactLogix Ethernet processor, associated chassis, power supply and scheduled I/O modules, Ethernet switch, UPS as shown and indicated on the contract drawings.
      b. Backup permanent generator provided in event of utility failure.

B. General Requirements:
   1. The process instrumentation and control system consists of the following functional divisions which will be defined in detail for each loop under Detailed Functional Description:
      a. Local Control Functions: includes local control panels, pilot control devices, instruments, and sensors.

b. Motor Control Center Functions: includes hardwired MCCs, DeviceNet networked MCCs, and pilot control devices located within these MCCs.

c. SCADA System Control Functions: includes PLC hardware, interface devices, and PLC logic.

d. SCADA System Monitoring Functions: includes graphical user interface hardware and configuration, event monitoring and logging functions, analog parameter trending, and alarm handling.

e. SCADA System Historical Data Functions: includes historical database, report configuration, and interface with the existing maintenance management software system.

2. The process instrumentation and control system includes existing PLCs, SCADA system servers and workstations, and network infrastructure. It shall be the responsibility of the system integrator to coordinate all efforts specified herein with these existing systems so as to minimize impact on facility operations.

3. PLC Programming

a. All PLC programming will be provided by Madison Metropolitan Sewerage District, MMSD.

4. SCADA/HMI Graphical Interface

a. All SCADA/HMI functions will be programmed and provided by MMSD.

5. Historical Data

a. All historical data will be developed and recorded by MMSD.

2.03 UNIT PROCESS NO. 1: JAMES STREET PUMP STATION

A. LOOP 1: INFLUENT PUMPING

1. General:

a. Provide (5) wetwell floats for level control in the wetwell.

b. Control of the pumps will be through the PLC using the floats.

c. Backup control will be activated by ~~the high level float and bypass the PLC~~loss of PLC activity and shall run the pumps in a fixed mode of operation via hard-wired controls.

d. Refer to P&ID.

2. Local Control Functions:

a. "Pump No. X Service Out/In" Selector switch.

1) With the switch in the "Out of Service" position, the pump is not available to run.

2) With the switch in the "In Service" position, the pump is available to run.

b. "~~Station~~Pump No. X Hand-Off-Auto" selector switch

~~1)~~ In "Hand", the pumps will be called ~~via start/stop pushbuttons,~~to run as long as the pump is ~~available.~~

~~2)~~1) ~~"Local" pilot light provides operator indication the system is~~ in ~~local control~~service.

2) In "Off", the pumps are inoperable.

3) In "Auto", the PLC will control the pumps in response to the floats, as long as the pump is in ~~available~~service.

~~a) "Computer" pilot light provides operator indication the system is in local control.~~

~~b)~~a) Pump alternation selector switch, "Alternation 1-2/AUTO/2-1" is provided ~~indication of pump alternation~~to alternate the pumps between service events.

~~c)~~b) In the event of a ~~"High Level Alarm",~~PLC failure, the ~~high level float~~ pump control will ~~activate~~automatically switch to hard wired logic in the control panel. Pump No.1 ~~via hardwire~~ will run as the lead pump and start with the "Lead Pump Start" float and pump down to the "Pumps Off" float. Pump No.2 shall operate as the lag pump and start with the "Lag Pump Start" float and pump the station down to the "Pumps Off" float. The ~~"Pumps Off" float will reset the~~hardwire backup control shall switch back to normal control once the PLC has re-enabled.

c. A push-pull normally closed "Emergency Stop" pushbutton, when push in, opening the circuit shall lock out the pumps until the pushbutton is pulled out.

d. "Running" pilot light shall be provided to indicate the pump is running.

e. "Stopped" pilot light shall be provided to indicate the pump is not running.

f. "Failed" pilot light shall be provided to indicate the pump has failed.

g. "High Level Alarm" pilot light shall be provided to indicate the wetwell has a high level.

h. "Low Level Alarm" pilot light shall be provided to indicate the wetwell has a high level.

~~i. "Backup Control" pilot light shall be provided to indicate the wetwell is in backup control.~~

3. With the switch in the "In Service" position, the pump is available to run

~~3.~~4. Pump Control Panel Functions:

a. The motor high temperature relay shall be located in the pump control panel. Provide "Motor High Temperature" pilot light in the event of a high motor temperature. Lock the pump out of operation in the event of a high motor temperature, requiring the "Alarm Reset" pushbutton to unlatch to lockout circuit.

b. The seal fail relay shall be located in the pump control panel. Provide "Seal Fail" pilot light. Do not lock the pump out in the event of a seal fail.

4.5. SCADA System Control Functions:

a. N/A

5.6. SCADA System Monitoring Functions:

a. Station In Auto
b. E-Stop
c. Pump Alternation 1-2
d. Pump No.x In Service
e. Pump No.x Running
f. Pump No.x Failed
g. Pump No.x Motor High Temperature
h. Pump No.x Seal Fail
i. Pump No.x KW
j. Pump No.x Amps
k. Pump No.x Start Pushbutton
l. Pump No.x Stop Pushbutton
m. Alarm Reset
n. Wetwell High Level Float
o. Wetwell Lag Start Float
p. Wetwell Lead Start Float
q. Wetwell Pumps Off Float
r. Wetwell Low Level Float
s. Wetwell In Backup Control

6.7. SCADA System Alarm Functions:

a. Incorporate the following alarm conditions into the alarm log and into the alarm notification system:
    1) Station In Auto
    2) E-Stop
    3) Pump No.x In Service
    4) Pump No.x Failed
    5) Pump No.x Motor High Temperature
    6) Pump No.x Seal Fail
    7) Wetwell High Level Float
    8) Wetwell Low Level Float
    9) Wetwell In Backup Control

7.8. SCADA System Historical Data Functions

a. Display, trend, and record the following parameters:
    1) Pump No.x Running
    2) Pump No.x Failed
    3) Pump No.x Motor High Temperature
    4) Pump No.x Seal Fail
    5) Pump No.x KW

6) Pump No.x Amps
7) Wetwell High Level
8) Wetwell Low Level
9) Wetwell In Backup Control

B. LOOP 2: STANDBY GENERATOR

1. General:
   a. A permanent generator will be provided for station power in the event of the utility power outage.
   b. Refer to P&ID.
2. Local Control Functions:
   a. ATS to monitor primary power source. If the primary source is lost, the generator shall be started and the ATS shall switch power to the generator.
   b. ATS to perform weekly exercise of generator
   c. Provide indicator light for Generator Failed/Not in Auto.
   d. Provide blue indicator light for "ATS Emergency Source Connected".
3. Motor Control Center Functions:
   a. N/A
4. SCADA System Control Functions:
   a. SCADA system shall be set up to perform generator exercise if needed.
5. SCADA System Monitoring Functions:
   a. Generator Running
   b. Generator Failed
   c. Generator Not In Auto
   d. ATS in Normal Position
   e. ATS Normal Source Available
   f. ATS in Emergency Position
   g. ATS Emergency Source Available
   h. ATS Not In Auto
   i. ATS Failed to Transfer
   j. ATS Initiate Test
6. SCADA System Alarm Functions:
   a. Incorporate the following alarm conditions into the alarm log and into the alarm notification system:
   b. Generator Running
   c. Generator Failed
   d. ATS Not In Auto
   e. ATS Failed to Transfer
7. SCADA System Historical Data Functions
   a. Display, trend, and record the following parameters:
   b. Generator Running

c. Generator Failed
d. Generator Not In Auto
e. Generator number of starts
f. Generator ETM
g. ATS in Normal Position
h. ATS Normal Source Available
i. ATS in Emergency Position
j. ATS Emergency Source Available
k. ATS Not In Auto
l. ATS Failed to Transfer
m. ATS Initiate Test

C. LOOP 3: PANEL INTRUSION
1. General:
a. A door limit switch will be provided on the main control panel door to monitor if the door is open. The switch will provide an input to the PLC for notification and to turn the panel lights on.
b. Refer to P&ID.
2. Local Control Functions:
a. Door switch activates light
3. Motor Control Center Functions:
a. N/A
4. SCADA System Control Functions:
a. Notification there is a panel entry
5. SCADA System Monitoring Functions:
a. Panel Entry
6. SCADA System Alarm Functions:
a. Incorporate the following alarm conditions into the alarm log and into the alarm notification system:
1) Panel Entry
7. SCADA System Historical Data Functions
a. Display, trend, and record the following parameters:
1) Panel Entry

D. LOOP 4: THREE PHASE POWER FAIL
1. General:
a. Provide voltage monitor to provide failed contact in an event the 3 phase power is inadequate.
b. Refer to P&ID.
2. Local Control Functions:
a. Provide a pilot light indicating a Station 3 phase power failure.
3. Motor Control Center Functions:
a. N/A
4. SCADA System Control Functions:
a. N/A

5. SCADA System Monitoring Functions:
   a. Monitor the voltage relay.
6. SCADA System Alarm Functions:
   a. Incorporate the following alarm conditions into the alarm log and into the alarm notification system:
      1) Station 3 Phase Power Failure
7. SCADA System Historical Data Functions
   a. Display, trend, and record the following parameters:
      1) Station 3 Phase Power Failure

E. LOOP 5: CONTROL POWER MONITORING
1. General:
   a. Provide a control power relay for indication to SCADA that control power is available.
   b. Primary power to the controls shall be provided by the UPS. Provide a relay on the UPS output. If the UPS power fails, the power shall be switched to regular control power.
2. Local Control Functions:
   ~~a. None.~~
   a. Provide pilot light for “UPS Failure”.
3. Motor Control Center Functions:
   a. N/A
4. SCADA System Control Functions
   a. N/A
5. SCADA System Monitoring Functions
   a. Control Power Available
   b. UPS Low Battery
   c. UPS Power Available
   d. UPS Service Required
6. SCADA System Alarming
   a. Control Power Failure
   b. UPS Service Required
   c. UPS Low Battery
7. SCADA System Historical Data Functions
   a. Control Power Available
   b. UPS Low Battery
   c. UPS Power Available
   d. UPS Service Required

F. LOOP 6: RADIO COMMUNICATIONS
1. General:
   a. The Master PLC will pole the pump station PLC in the site rotations. If communications cannot be made, a communications failure will be generated at the master SCADA.

2. Local Control Functions:
   a. None.
3. Motor Control Center Functions:
   a. N/A
4. SCADA System Control Functions
   a. Maintain this site in the radio communications
5. SCADA System Monitoring Functions
   a. Communications
6. SCADA System Alarming
   a. Communications Failure
7. SCADA System Historical Data Functions
   a. Communications Failure

G. LOOP 7: YARD LIGHT (FUTURE)
1. General:
   a. Yard light is left as future, mainly to get a conduit stubbed out for future use.
2. Local Control Functions:
   a. None.
3. Motor Control Center Functions:
   a. N/A
4. SCADA System Control Functions
   a. N/A
5. SCADA System Monitoring Functions
   a. N/A
6. SCADA System Alarming
   a. N/A
7. SCADA System Historical Data Functions
   a. N/A

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK (NOT USED)

3.02 FIELD MEASUREMENTS

A. Field verify with exact measurements, the available mounting space for control system equipment. Actual field conditions govern all final installed locations, distances, and levels.

B. Identify conflicts prior to beginning installation.

C. Where ranges are indicated on the contract documents, they are to be considered preliminary. Field verify the exact ranges required based on field conditions.

3.03 DELIVERY STORAGE AND HANDLING

A. It shall be the responsibility of the installing contractor to receive all process instrumentation and control equipment at the job site. Carefully inspect all equipment for damage prior to accepting from the shipping agency. Do not accept shipment if damage is evident.

B. Exercise due diligence in storing, protecting, and moving process instrumentation and control equipment. Damaged or worn equipment will not be accepted and will be replaced at no additional cost to the Owner.

3.04 INSTALLATION

A. Install equipment in locations as indicated on the contract documents. Adjust locations as needed to ensure operability, serviceability, and compliance with all applicable codes and standards.

B. Installation shall be completely tested prior to start-up. This work includes verification of all field wiring continuity and proper termination of wiring.

3.05 TESTING AND START-UP SERVICES

A. System Integrator shall provide installation and start-up services required to place the complete system into operation.

B. Each signal and function shall be fully tested. These tests shall be based on actual operation of primary elements and verification of proper control system response. Submit test results as part of Operations and Maintenance Manual.

C. Record calibrations of all analog devices.

D. Demonstrate proper operation of the process and instrumentation control system to the Owner and in the presence of the Engineer.

3.06 TRAINING

A. Training shall be suitable for plant operations personnel with limited knowledge of electrical components.

B. Provide two instructor days of operator training at the job site. Training shall consist of operations instruction and maintenance/trouble-shooting instruction.
   1. Operations instruction shall identify all control loops with description of all interlocks, interface with other loops, and operational input requirements. Describe procedures for re-starting the system.
   2. Maintenance instruction shall identify periodic maintenance that can be performed by the operator. Provide description of procedures and locations

for replacement of consumable devices such as fuses and for checking the calibration or operation of devices.

3. Trouble-shooting instruction shall identify simple procedures and methods for identifying potential causes in the event of failures. For example, instruct operator on correlation of input signals and PLC I/O module indicator lights.

END OF SECTION

SECTION 26 90 10

CONTROL PANEL CONSTRUCTION

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. Applicable provisions of Part I shall govern the work of this section.

B. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards:
    a. ANSI/NFPA 70 - National Electrical Code (NEC) and state amendments thereto.
    b. ANSI/NFPA 79 - Electrical Standard for Industrial Machinery.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. American National Standards Institute/Instrument Society of America (ANSI/ISA), Specifications and Standards, current edition.
6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition.
    a. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
    b. NEMA ICS6 - Enclosures for Industrial Controls and Systems
7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
    a. UL50 - Cabinets and Boxes
    b. UL508 - Industrial Control Equipment
    c. UL508A - Industrial Control Panels
    d. UL94 - Flammability of Plastic Materials
8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), current edition.
    a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
10. International Electrical Testing Association (NETA)

a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

11. Canadian Standards Associates (CSA), Specifications and Standards, Current Edition.
    a. CSA Standard C22.2 No. 0 - General Requirements - Canadian Electrical Code, Part II
    b. CSA Standard C22.2 No. 0.4 - Bonding and Grounding of Electrical Equipment (Protective Equipment)
    c. CSA Standard C22.2 No. 14 - Industrial Control Equipment for Use in Ordinary (Non-Hazardous) Locations
    d. CSA Standard C22.2 No. 40 - Cutout, Junction, and Pull boxes
    e. CSA Standard C22.2 No. 94 - Special Purpose Enclosures
12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
13. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.
    a. IEC 60529 - Classification of Degrees of Protection Provided by Enclosures
    b. IEC 60204 - Safety of Machinery - Electrical Equipment of Machines
    c. IEC 60079 - Electrical Apparatus for Explosive Gas Atmospheres

1.03 DESCRIPTION OF WORK

A. For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of:
   1. Section 26 90 00 - Process Instrumentation & Control

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

1.05 SUBMITTALS

A. Submit shop drawings as specified herein.

B. Submit shop drawings for the equipment specified herein as part of the complete, integrated submittal for the process instrumentation & control system and in accordance with the requirements specified under Section 26 90 00 - Process Instrumentation and Control.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation & maintenance manuals and instructions as specified herein.

B. Submit operation and maintenance manuals for the equipment specified herein as part of the complete, integrated manual for the process instrumentation and control system and in accordance with the requirements specified under 26 90 00 - Process Instrumentation and Control.

1.07 FACTORY TESTING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

1.08 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. All control panels shall be constructed in accordance with UL 508 standards and shall bear the UL 508 listing.

1.09 WARRANTY

A. See Division 01 for additional requirements.

1.10 EXTRA MATERIALS

A. See Division 01 for additional requirements.

B. Provide one spare vapor phase corrosion-inhibiting capsule for each control panel.

C. Provide twenty percent of the total number of terminals as installed spares in each control panel.

D. Provide 3 spare control relays of each type utilized within each control panel.

E. Provide 3 spare fuses of each type utilized within each control panel

1.11 DESIGN REQUIREMENTS

CONTROL PANEL(S)

TAG NUMBER	DESCRIPTION	TYPE	SIZE	NOTES
	JAMES ST PUMP STATION	B	72”H x 86”W x 24” D	1

SCS-1	SUPERVISORY CONTROL SYSTEM	A	36”H x 30”W x 12”D	1
PCP-1	PUMP CONTROL PANEL	A	36”H x 24”W x 12”D	1
PCP-2	PUMP CONTROL PANEL	A	36”H x 24”W x 12”D	1
PDP	POWER DISTRIBUTION PANEL	A	24”H x 24”W x 12”D	1

NOTES:

1. Specified size indicates the physical size anticipated by the ENGINEER. CONTRACTOR shall verify actual size with SYSTEM INTEGRATOR and adjust installation accordingly.

1.12 MAINTENANCE

A. Before substantial completion, perform all maintenance activities required by any sections of the specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems into service.

B. Furnish all spare parts as required by other sections of the specifications.

PART 2 PRODUCTS AND MATERIALS

2.01 GENERAL REQUIREMENTS

A. Fabricate, install instruments, plumb and wire in factory.

B. Test wiring and plumbing prior to shipment.

C. Make external connections by way of numbered terminal blocks.

D. Separate electrical components from pneumatic and hydraulic components by metal barriers.

E. Conform to ISA standards.

2.02 TYPE A - CONTROL PANEL ENCLOSURE, WALL-MOUNTED

A. Manufacturer:
   1. Hoffman Enclosures, Inc. Concept Wall-Mount Enclosure
   2. Saginaw Control and Engineering, Enviroline Series Wall-Mount Enclosure
   3. or equal

B. Environmental Rating:
   1. NEMA Type 4/4X/12

C. Construction:
   1. 16 gauge or 14 gauge steel
   2. Seams continuously welded and ground smooth
   3. Minimum width body flange trough excludes liquids and contaminants

4. Integral body grounding stud
5. Panel mounting studs
6. Mounting holes in back of body for direct mounting
7. Hidden hinges for clean aesthetic appearance
8. Standard full access 170 degree door opening
9. Doors are interchangeable and easily removable by pulling captive hinge pins
10. Door bar on hinge side for wire management and grounding
11. Additional door bar and stiffener on larger enclosures for extra rigidity
12. High-impact thermoplastic data pocket
13. Seamless foam-in-place one-piece gasket provides oil-tight and dust-tight seal against contaminants
14. Self-grounding latch system with double seal provides maximum protection against leakage
15. Quarter-turn door latching system installed on door with a slotted insert
16. Finish:
    a. Gray painted steel
    b. Steel sub-panels are painted white

2.03 TYPE B - CONTROL PANEL ENCLOSURE, FREE-STANDING

A. Manufacturer:
1. Hoffman Enclosures, Inc.
2. Saginaw Control and Engineering, Enviroline Series
3. or equal

B. Environmental Rating:
1. NEMA Type ~~4/4X/12~~3R

C. Construction:
1. 12 gauge stainless steel
2. Seams continuously welded and ground smooth
3. Minimum width body flange trough excludes liquids and contaminants
4. Integral body grounding stud
5. Panel mounting studs
6. 18 inch legs with louvered skirting
7. Hidden hinges for clean aesthetic appearance
8. 3-point latching system with padlockable rotating handles
9. Door stops on exterior doors.
10. Door bar on hinge side for wire management and grounding
11. Additional door bar and stiffener on larger enclosures for extra rigidity
12. High-impact thermoplastic data pocket
13. Seamless foam-in-place one-piece gasket provides oil-tight and dust-tight seal against contaminants
14. Self-grounding latch system with double seal provides maximum protection against leakage
15. Finish:

a. Brushed stainless steel
b. Steel sub-panels are painted white

16. Two door enclosures shall NOT have a center mullion/divider.
17. Backpan shall be one piece, not two piece.

PART 3 CONSTRUCTION METHODS

3.01 FIELD MEASUREMENTS

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

3.02 DELIVERY STORAGE AND HANDLING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

3.03 INSTALLATION

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

3.04 CONTROL PANEL FABRICATION AND ENVIRONMENTAL PROTECTION REQUIREMENTS

A. Instrument Mounting:

1. Locate instruments designated for back-of-panel mounting in manner to allow for maintenance and adjustment.
2. Panels 36” tall or shorter are to be mounted 54” from finished floor to centerline of panel. Panels over 36” tall are to be mounted no higher than 72” from finished floor to top of panel.
3. Instrument mounting height shall not exceed 70”. Minimum height shall be 48”.
4. Operator interface terminals are to be 54” from finished floor to centerline of screen, but the top of the visible screen shall not exceed 60” above finished floor.
5. Panel cutouts for instruments and other devices, such as lights and switches, shall be cut, punched, or drilled and smoothly finished with rounded edges.
6. Provide steel angle stiffeners on back of panel face to prevent panel deflection under instrument loading or operation.
7. Provide internal structural steel framework for instrument support purposes and panel bracing. Internal framework shall permit lifting of panel without racking or distortion.
8. All components inside pump station enclosure shall be housed in separate control panels. The Supervisory Control System SCS-1, Pump Control Panels PCP-1 and PCP-2, lighting panel LP-1 & the Power Distribution Panel PDP shall all be house in a separate enclosures.

9. All interconnections between panels inside of the pump station panel shall be done with galvanized rigid steel conduit with LBs.
10. UPS to be shelf mounted.

B. Corrosion Protection:
1. Provide vapor phase corrosion inhibiting capsules in each control panel to protect all exposed metal surfaces for a period of at least two years. Corrosion inhibiting modules shall be Northern Instrument Corporation, Zerust vapor capsules Model VC-2-2 or Hoffman Engineering Corporation corrosion inhibitor Model A-HCI-5.
2. Provide thermostatically controlled condensation heater in panels located in high humidity areas and in areas in which ambient temperature will vary. Heater shall be sized to prevent condensation within panel.

C. Heating, Ventilating, and Air Conditioning:
1. Provide heating equipment as specified under Part B.
2. Provide filtered ventilation fan(s) where needed and sized to dissipate heat generated by components located within control panel.
a. Filtered ventilation fans are to push air inward into control panel.
3. Provide filtered air conditioning equipment and insulate panel where needed to maintain internal panel temperature within operating parameters of internal panel components.

3.05 CONTROL PANEL ELECTRICAL REQUIREMENTS

A. Electric Service:
1. Design control panel to operate on electrical supply indicated on the drawings.
a. Three phase service:
1) Provide main circuit breaker disconnect switch with through the door operator handle.
2) Provide branch circuit breakers for distribution of three phase and single phase power at voltages above 120VAC.
a) Provide through the door disconnect handle.
3) Control panel and internal components shall be rated to interrupt the available fault current.
4) Main circuit breaker and branch circuit breakers shall be coordinated such that a fault in a branch circuit will trip only the branch circuit breaker and not the main circuit breaker.
5) Separate 480VAC wiring from control voltage wiring.
6) Provide appropriately sized control power transformer.
7) Provide miniature circuit breakers for distribution of 120VAC control power in accordance with the following:
a) No more than 20 devices on any single circuit.
b) Where multiple units perform parallel operations, do not group all devices on the same branch circuit. The

purpose is to prevent the failure of any single branch circuit from shutting down at entire operation.

c) Do not exceed the ampacity of the branch circuit.

d) Panel service outlet shall be protected by separate branch circuit breakers and be labeled with ampacity rating.

e) Power supplies shall be protected by separate branch circuit breakers.

8) Provide 20 amp, 120VAC service outlet circuit within back-of-panel area.

9) Control power transformer fuses and branch circuit breakers shall be coordinated such that a fault in a branch circuit will trip only the branch circuit breaker and not the control power transformer fuses.

10) Branch circuit breakers shall be rated for 15A and 250VAC.

11) Fuses shall not be substituted for circuit breakers.

b. Single phase service:

1) Provide main circuit breaker with disconnect switch.

2) Provide miniature circuit breakers for distribution of 120VAC control power in accordance with the following:

a) No more than 20 devices on any single circuit.

b) Where multiple units perform parallel operations, do not group all devices on the same branch circuit. The purpose is to prevent the failure of any single branch circuit from shutting down at entire operation.

c) Do not exceed the ampacity of the branch circuit.

d) Panel service outlet shall be protected by separate branch circuit breakers

e) Power supplies shall be protected by separate branch circuit breakers.

3) Provide 20A, 120VAC service outlet circuit within back-of-panel area.

4) Main circuit breaker and branch circuit breakers shall be coordinated such that a fault in a branch circuit will trip only the branch circuit breaker and not the main circuit breaker.

5) Branch circuit breakers shall be rated for 15A and 250VAC.

6) Fuses shall not be substituted for circuit breakers.

c. Uninterruptible power supply:

1) Provide true online uninterruptible power supply, provide distribution of 120VAC power on the line and load sides of the UPS.

2) Panel service outlet, heater and other non-critical loads shall be powered from the line side of the UPS. Critical loads, including but not limited to all digital control equipment, shall be powered from the load side of the UPS.

3) Provide UPS bypass circuitry in the event the UPS fails.

d. Back-up control systems:
1) Where panel includes fail-safe back-up control circuitry, the back-up control circuits shall be fed with a separate circuit from a lighting panel or from a separate control power transformer.

B. Output Signal Fusing:
1. Provide appropriately sized fuses for all output signals to devices located external to the panel in accordance with the following requirements:
a. Maximum fuse size: 5A
b. Separate fuse for each device
c. Fuses shall be installed in indicating type fuse holder terminal blocks.

C. Control Panel Wiring:
1. Wiring within panels, consoles, racks, and cabinets shall meet the following requirements:
a. Wires for ac circuits shall be 300V or 600V, Type MTW stranded tin plated copper and shall be sized for the current to be carried but no smaller than No.16 AWG.
b. Wires for analog signal circuits shall be 300V stranded tin plated copper and shall be twisted shielded pairs/triads no smaller than No.18 AWG.
c. Wires for other dc circuits shall be 300V, Type MTW stranded tin plated copper but no smaller than No.16 AWG.
d. Wiring for special signals such as communications, digital data, and multiplexed signals shall use manufacturers' standard cables.
e. Every effort is to be made to separate wiring of different voltages. Where wiring of different voltages are near each other, they should cross perpendicular to each other.
f. Provide 1-1/2" spacing between wire trough and terminal blocks.
g. Provide 1-1/2" spacing between wire trough and components.
h. All wiring shall have heat shrink wire numbers.
i. All 3 phase wiring shall have phase tape on both ends of the conductors.
2. Components/Din Rail
a. Provide din rail for panel components.
b. Provide 25% spare din rail space
c. Fuse holders shall have indicator lights
d. Provide 25% spare back panel space for future devices.
3. Terminal blocks for panels, consoles, racks, and cabinets shall meet the following requirements:
a. Wire all spare or unused panel mounted elements, including PLC input/output points, to terminal blocks.
b. Provide open construction terminal blocks for wiring that is entirely internal to the panel.

c. Provide isolation switch terminal blocks for all wiring that is not entirely internal to the panel.
d. Rail-mount individual terminals to create a complete assembly. Provide terminals constructed such that jumpers can be installed with no loss of space on terminal or rail.
e. Size all terminal block components to allow insertion of all necessary wire sizes and types.
f. Provide power distribution blocks for distribution of control panel power at voltages exceeding 120VAC.
g. Provide wire troughs on both sides of terminal strips. Provide wire troughs for field wiring. Maximum fill of wire trough shall be 60%.
h. Any wiring not in a wire trough shall be ran in spiral wrap and secured to panel with tie wraps.
i. Provide 25% spare terminal blocks of each type. (120VAC, Neutral, DC power, control, 4-20 signals and intrinsic circuits)

4. Grounding:
a. Panels, consoles, racks, and cabinets shall be provided with an isolated copper grounding bus for all signal and shield ground connections. This ground bus shall be grounded at a common single ground point. The signal grounding system shall meet National Electrical Code requirements.
b. Each analog loop shall only be grounded at a single point for the loop. This single point shall be at the location of the dc power supply for the loop.

D. Power Supplies:
1. Provide dc power supplies as required to power instruments requiring external dc power, including two-wire transmitters and dc relays.
2. Power supplies shall be suitable for intrinsically safe circuits where two-wire transmitters are located in a hazardous area.

E. Electrical Transient Protection:
1. All electrical and electronic elements of the control system shall be protected against damage due to electrical transients induced in interconnecting lines from lighting discharges and nearby electrical systems.
2. Surge Suppressor Locations:
a. As a minimum, provide surge suppressors at the following locations:
1) Provide 480VAC, panel mounted surge suppressor on the load side of each 480VAC main circuit breaker in each panel.
2) Provide 120VAC, panel mounted surge suppressor on the load side of each 120VAC main circuit breaker in each panel.
3) Provide 24VDC, panel mounted surge suppressor at the panel connections of all analog signal circuits that have any

portion of the circuit extending outside of a protecting building.

4) Provide 24VDC, field mounted surge suppressor at the field connection of each analog signal transmitter located outside of a protecting building.

3.06 STANDARD SIGNAL INTERFACES

A. Unless otherwise specified discrete input and output signals shall conform to the following:
   1. Isolated unpowered (dry) contact closures.
   2. Power contact from panel receiving signal or device receiving signal.

B. Unless otherwise specified input and output analog signals shall conform to following:
   1. External to panel: isolated, 4-20 mADC.
   2. Internal to panel: 4-20 mADC signals.
   3. For 2-wire transmitter provide isolated type and power with 24VDC from panel or device receiving signal.
   4. Where isolation is required to interface with particular equipment or because of loop impedance, provide isolated, DC-to-DC transmitter.

3.07 TESTING AND START-UP SERVICES

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

3.08 TRAINING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

END OF SECTION

SECTION 26 90 11

CONTROL PANEL COMPONENTS

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern the work of this section.

B. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs.

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
    a. ANSI/NFPA 70 - National Electrical Code and state amendments thereto.
    b. ANSI/IEEE C37.90 - IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.
    c. ANSI/IEEE C62.11- IEEE Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits.
    d. ANSI/IEEE C62.34 - IEEE Standard for Performance of Low-Voltage Surge-Protective Devices (Secondary Arresters).
    e. ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
    a. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
    b. Insulated Cable Engineers Association (ICEA)
    c. International Society of Automation (ISA)
3. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition:
    a. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
    b. NEMA ICS 3 - Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC.

4. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition:
    a. UL508 - Industrial Control Equipment.
    b. UL508A - Industrial Control Panels.
    c. UL 913 - Intrinsically Safe Specification.
    d. UL94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
5. Wisconsin Department of Safety and Professional Services (DSPS)
6. National Electrical Contractors Association (NECA), current edition.
    a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
7. International Electrical Testing Association (NETA)
    a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
8. Canadian Standards Association (CSA), Specifications and Standards, current edition.
    a. CSA C22.2, Industrial Control Equipment.
9. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
10. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.
    a. IEC 60529 - Classification of Degrees of Protection Provided by Enclosures
11. CE - European Community, Applicable Directives.
    a. EN50005 - for Terminal Markings.
    b. EN50081-1- Generic Emission Standard.
    c. EN50082-1 - Generic Immunity Standard.
    d. EN61000-4-4 - Electromagnetic compatibility (EMC). Testing and measurement techniques.
    e. EN61000-4-5 - Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test.

1.03 DESCRIPTION OF WORK

A. For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of:
    1. Section 26 90 00 - Process Instrumentation & Control

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

1.05 SUBMITTALS

A. Submit shop drawings in accordance with Division 01.

B. Submit shop drawings for the equipment specified herein as part of the complete, integrated submittal for the process instrumentation & control system and in accordance with the requirements specified under Section 26 90 00 - Process Instrumentation & Control.

1. Furnish manufacturer literature sufficient in scope to demonstrate compliance with the requirements of this specification.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation & maintenance manuals and instructions as specified herein.

B. Submit operation and maintenance manuals for the equipment specified herein as part of the complete, integrated manual for the process instrumentation and control system and in accordance with the requirements specified under 26 90 00 - Process Instrumentation and Control.

1.07 FACTORY TESTING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

1.08 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.09 EXTRA MATERIALS

A. Supply five spare fuses of each type supplied for this project

B. Supply five spare lamps of each type supplied for this project.

C. Supply two spare relays of each type supplied for this project.

1.10 DESIGN REQUIREMENTS (NOT USED)

1.11 MAINTENANCE

A. Before substantial completion, perform all maintenance activities required by any sections of the specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems into service.

B. Furnish all spare parts as required by other sections of the specifications.

PART 2 PRODUCTS AND MATERIALS

2.01 CIRCUIT BREAKER - MINIATURE

A. Manufacturer:
1. Allen Bradley 1498-M
2. Or equal

B. Agency Approvals:
1. UL Listed

C. General:
1. DIN rail mounting in one-, two- and three-pole construction.
2. Used for overcurrent protection and switching on both ac and dc systems.

D. Construction:
1. Terminal lug wire size: 1- No.14 - No.2 AWG Cu or Al
2. Reversible line and load lugs for convenient flush or surface mount wiring
3. DIN mounted (symmetrical rail 35 x 7.5 DIN/EN 50 022)
4. UL Listed as HACR type -- 15A to 70A
5. Field installable quick connectors
6. Single handle with internal common trip
7. UL Listed 48VDC (5,000 AIR)

2.02 PILOT DEVICE - INDICATING LIGHT

A. Manufacturer:
1. Allen Bradley Bulletin 800T/800H
2. Eaton/Cutler-Hammer
3. Schneider Electric/Square D.
4. Or equal

B. Agency Approvals:

1. UL Listed
2. CSA Certified
3. CE Compliant

C. Mechanical:
   1. Size: 30.5 mm
   2. Environmental rating:
      a. NEMA 4/13 watertight/oil tight: NEMA 1, 12, 3R, 4 control panels
      b. NEMA 4/4X corrosion resistant: NEMA 4X control panels and remote control stations
   3. Life expectancy: 200,000 operations
   4. Push-to-test, transformer type, dual input

D. Electrical:
   1. Input power: 120VAC
   2. Lamp:
      a. High visibility, 28 chip cluster LED
      b. Color: red, green, amber, as scheduled
   3. Lens: High impact plastic, colored to match lamp

E. Nameplate: Standard or jumbo with engraved service legend

F. Field Mounted Control Stations:
   1. Type I Enclosure: NEMA 4X polycarbonate enclosure
   2. Type II Enclosure: NEMA 4X stainless steel enclosure
   3. Type III Enclosure: NEMA 7 hazardous location enclosure

2.03 PILOT DEVICE - PUSHBUTTON

A. Manufacturer:
   1. Allen Bradley Bulletin 800T/800H
   2. Eaton/Cutler-Hammer
   3. Schneider Electric/Square D
   4. Or equal

B. Agency Approvals:
   1. UL Listed
   2. CSA Certified
   3. CE Compliant

C. Mechanical:
   1. Size: 30.5 mm
   2. Environmental rating:
      a. NEMA 4/13 watertight/oil tight: NEMA 1, 12, 3R, 4 control panels

b. NEMA 4/4X corrosion resistant: NEMA 4X control panels and remote control stations

3. Life expectancy: 10,000,000 operations
4. Momentary contact, non-illuminated

D. Electrical:
1. Rated Voltage: 120VAC
2. Continuous current rating:
a. AC: 10A
b. DC: 2.5A
3. Operational current:
a. Make: 7200VA
b. Break: 720VA
4. Operator:
a. Mushroom head: Emergency stop service
b. Flush-head: All other services

E. Nameplate: Standard or jumbo with engraved service legend

F. Field Mounted Control Stations:
1. Type I Enclosure: NEMA 4X polycarbonate enclosure
2. Type II Enclosure: NEMA 4X stainless steel enclosure
3. Type III Enclosure: NEMA 7 hazardous location enclosure

2.04 PILOT DEVICE - SELECTOR SWITCH

A. Manufacturer:
1. Allen Bradley Bulletin 800T/800H
2. Eaton/Cutler-Hammer
3. Schneider Electric/Square D.
4. Or equal

B. Agency Approvals:
1. UL Listed
2. CSA Certified
3. CE Compliant

C. Mechanical:
1. Size: 30.5 mm
2. Environmental rating:
a. NEMA 4/13 watertight/oil tight: NEMA 1, 12, 3R, 4 control panels
b. NEMA 4/4X corrosion resistant: NEMA 4X control panels and remote control stations
3. Life expectancy: 1,000,000 operations

4. Maintained contact, non-illuminated (spring return from right or left where scheduled)

D. Electrical:
1. Rated Voltage: 120VAC
2. Continuous current rating:
a. AC: 10A
b. DC: 2.5A
3. Operational current:
a. Make: 7200VA
b. Break: 720VA
4. Operator:
a. Standard knob operator, two-position, or three-position
b. Keyed operator: where scheduled

E. Nameplate: Standard or jumbo with engraved service legend

F. Field Mounted Control Stations:
1. Type I Enclosure: NEMA 4X polycarbonate enclosure
2. Type II Enclosure: NEMA 4X stainless steel enclosure
3. Type III Enclosure: NEMA 7 hazardous location enclosure

2.05 POWER SUPPLY - 12/24VDC

A. Manufacturer:
1. Allen Bradley 1606 family

B. Agency Approvals:
1. UL Listed
2. CE Marked

C. Mechanical:
1. Enclosure:
a. IP20
b. Sealed plastic
c. Fine ventilation grid
2. Mounting: DIN rail

D. Electrical
1. Capacity:
a. Size to power connected loads. Reserve 25 percent of capacity for future use.
b. Provide multiple power supplies where needed to accommodate load.
2. Input:

a. Voltage: 85-264VAC
b. Frequency: 43-67Hz
c. Efficiency: 88.5 percent
d. Current: 1.0A at 100VAC

3. Output:
a. Voltage: 24-28VDC or 10-12VDC
b. Voltage regulation: 2 percent
c. Overvoltage protection: 40VDC
d. Noise suppression: EMI values below EN50081-1
e. Current: 5.0A at 24VDC or 4.5A at 12VDC

4. Monitoring:
a. LED Indicator
b. Output power good status contact

2.06 POWER SUPPLY - 120VAC, Uninterruptible

A. Manufacturer:
~~1. Eaton/Powerware 9130~~
~~2. Liebert~~
1. Allen Bradley
2. APC
3. Or equal

B. Agency Approvals:
1. UL Listed
2. CE Marked
3. FCC Approved

C. General:
1. Topology: True online, double-conversion
2. Diagnostics: Full system self-test on power up
3. UPS Bypass Automatic: on Overload or UPS failure less than 4 ms
4. Transfer Time to battery: 0 ms
5. Overload Capacity:
a. 125 percent for 10 minutes before transfer to bypass
b. 150 percent for 10 seconds before transfer to bypass

D. Input:
1. Input voltage: 80-144VAC, single phase, 60 Hz
2. Input power factor: greater than 95 percent
3. Input Line: NEMA 5-15 plug and cord
4. Protection: fuse or circuit breaker

E. Electrical Output:
1. Voltage Regulation:

a. On Utility: +/-2 percent of nominal
b. On Battery: +/-3 percent of nominal

2. Nominal Output Voltage: Same as selected input voltage
3. Output Voltage Waveform: Sine Wave
4. Output Voltage Distortion: less than 3 percent THD
5. Output Line: 4 NEMA 5-15 receptacles, minimum
6. Output protection: Electronic overload sensing, and circuit breaker protection
7. Efficiency:
   a. Online Mode: greater than 86 percent
   b. Hi-Efficiency Mode: greater than 90 percent

F. Battery:
1. Internal Battery type: Sealed, lead-acid; maintenance free
2. On Battery Runtime: 125% of rated load for ten minutes
3. Battery Replacement: Hot-swappable internal batteries
4. Recharge Time: less than 4 hours to 90 percent capacity
5. Start-On-Battery: Allows start of UPS without utility input

G. Environmental:
1. Temperature:
   a. Operating: 32 to 104 degrees F
   b. Storage: 5 to degrees 122 F
2. Relative Humidity: 0 to 95 percent non-condensing
3. Audible Noise at 1 meter: less than 52dB
4. Altitude: 10,000 feet without deteriorating

H. Communications:
1. Relay Output Card:
   a. Line Fail
   b. Low Battery
   c. UPS Fault
   d. Bypass
2. User Interface: LCD status screen
3. Audible Alarms UPS alarm conditions, including:
   a. On-Battery
   b. Low Battery
   c. Overload
   d. UPS Fault
4. Communications: One ~~RS232~~ Serial Port; One Communications Slot; One USB Port
~~5. Communications cable: 6-foot communications cable included~~
~~6. Power Management Software: Powerware Software Suite CD~~

I. Manufacturer’s Warranty:

1. Warranty: 2 year comprehensive, including battery
2. ~~Equipment Protection Policy: $25,000 lifetime protection including lightning damage~~

2.07 RELAY - 120V GENERAL PURPOSE

A. Manufacturer:
   1. Allen Bradley Bulletin 700-HB
   2. IDEC RU Series
   3. Or equal

B. Agency Approvals:
   1. UL Listed
   2. CE Marked

C. Mechanical:
   1. Enclosure: Transparent dust cover
   2. Contacts: Silver cadmium oxide
   3. Insulating Material: Molded, high dielectric
   4. Terminal Markings: In accordance with EN50-0005
   5. Life expectancy: 10,000,000 operations
   6. Operations:
      a. Pickup: 20 mS
      b. Dropout: 4 mS
      c. Maximum Rate: Four operations per second
   7. Blade style, quick connect terminals

D. Electrical:
   1. Contacts:
      a. Double-pole, double throw
      b. Rated thermal current: 15A
      c. Make: 60A
      d. Break: 6A
   2. Coil:
      a. 120 VAC + 10, -20 percent
      b. Consumption.
         1) Inrush: 2.85 VA
         2) Sealed: 1.9 VA
   3. Voltage:
      a. Rated Insulation Voltage: 250V IEC-300V UL/CSA
      b. Dielectric Withstand Voltage:
         1) Pole-to-Pole: 1500V
         2) Contact to Coil: 6000V
         3) Contact to Frame: 4000V
   4. Push-to-Test Operator

5. Pilot light

E. Relay Socket:
1. 11-blade
2. Finger-safe terminal
3. DIN rail mounted
4. Double tier
5. Retainer clip
6. Relay identification snap-in markers

2.08 RELAY - SOLID STATE

A. Manufacturer:
1. Allen Bradley Bulletin 700-SH
2. IDEC RSS Series
3. Or equal

B. Agency Approvals:
1. UL Recognized
2. CE Marked

C. Electrical:
1. Input:
a. Voltage: 4-32VDC
b. Impedance: 15mA, maximum, voltage dependent
c. Pick-up voltage: 4VDC
d. Drop-out Voltage: 1VDC
e. Dielectric Strength: 2500VACrms
f. Reverse voltage protection
2. Output:
a. Continuous current: 10A
b. Voltage range: 19-264VAC
c. Contact: SPST - N.O.
d. Off State leakage: 5 mA max (at 100VAC)
e. Turn-On/Turn-Off time; 0.5 cycle
3. Features:
a. Photo isolation
b. Dual SCR output
c. Built-in snubber

2.09 RELAY - TIME DELAY

A. Manufacturer:
1. Allen Bradley Bulletin 700-HT
2. IDEC, RTE Series

3. Or equal

B. Agency Approvals:
1. UL Listed
2. CE Marked

C. Mechanical:
1. Insulation resistance: 100 Mohms, minimum
2. Dielectric strength: 1500VAC, 1 minute
3. Vibration resistance: 6N
4. Shock resistance: 500N
5. Operating temperature: -20 to 65 degrees C
6. Operating humidity: 45 to 85 percent, relative
7. Blade style: quick-connect terminals

D. Electrical:
1. Contacts:
a. Two Form C double-pole, double-throw
b. 10A, 240VAC, resistive
2. Timing functions:
a. Delay on make/interval
b. Delay on break/single shot
c. Range: 0.1 seconds - 30 minutes
3. Accuracy:
a. Repeat: + 0.25 percent
b. Voltage: + 1.0 percent
c. Temperature error: + 2.0 percent
d. Setting error: + 10.0 percent
4. Status
a. Indicator light for timer timed out
b. Indicator light for timer in progress

E. Relay Socket:
1. 8 or 11-blade
2. Finger-safe terminal
3. DIN rail mounted
4. Double tier
5. Retainer clip
6. Relay identification snap-in markers

2.10 WIRE DUCT

A. Manufacturer:
1. Panduit Electro-Duct

B. General Description:
1. Plastic wire duct
2. Maximum wire fill to be 60%

2.11 SURGE SUPPRESSOR - 24VDC

A. Manufacturer:
1. Allen Bradley 4983-DD
2. Or equal

B. Agency Approvals:
1. UL 497B

C. General Description:
1. Transient Protection for Low-Voltage Signal Lines
2. Sneak/Fault Current Protection
3. Resettable Fusing-PTCs
4. Differential and Common Mode Protection
5. Automatic Recovery
6. Encapsulated in Stainless Steel Pipe Nipples
7. Silicon Avalanche Hybrid Technology
8. UL 497B Listed
9. Protection for One Pair (Two Wires & Shield on SS65)

D. Electrical:
1. Response Time: less than 1 nanosecond
2. Maximum Signal Voltage: 28VDC
3. DC Clamping Level:
   a. Line-to-Ground: 36V +/-l0 percent
   b. Line-to-Line: 72V +/-l0 percent
4. Maximum Let-Thru Voltage:
   a. Line-to-Ground (10x700 microseconds): 44V at 400A
   b. Line-to-Line (10x700 microseconds): 90V at 400A
5. Series Resistance (per conductor): 5 Ohms (typical)
6. Capacitance (zero volts bias):
   a. Line-to-Line: 600pf typical
   b. Line-to-Ground: 1200pf typical
7. Number of Occurrences: 400 at 500 Amps (10x1000 microseconds)

2.12 SURGE SUPPRESSOR - 120VAC SIGNAL, PANEL MOUNTED

A. Manufacturer:
1. Allen Bradley 4983-DS
2. Or equal

B. Agency Approvals:
   1. UL Listed

C. General Description:
   1. Performance exceeds highest class severity level of IEC/EN 61000-4-4 and 61000-4-5
   2. Enhanced filtering to attenuate high frequency and bring equipment into compliance with IEEE /ANSI C37.90.1
   3. Universal hardwired version for all I/O modules including AC, DC, contact output, current output and signal input
   4. Multi-stage design provides the most effective suppression and filtering available, and requires no additional secondary protection
   5. Sub-nano second response time stops failures due to lightning, spikes and over-voltage surges while filtering all other electrical noise
   6. Plug-in replaceable daughter card modules contain all active surge suppression
   7. Space efficient protector is hermetically sealed and suitable for the most harsh industrial environments
   8. Universal DIN-Rail mounting allows easy installation on any standard DIN-Rail configuration
   9. Automatic reset and fail safe design requires no maintenance. Eliminates "Out of Service" downtime and repair/replacement costs caused by damaging electrical surges
   10. Protection for current loop instrumentation and low frequency signal/data lines
   11. UL-497B listed for Data Models (60 VDC or less) UL file E205158

D. Electrical:
   1. Signal Channels: 5, 10, 15, or 20
   2. Operating: +/-30VDC
   3. Maximum Operating Voltage: 33VDC
   4. Maximum Operating Current: 0.5A
   5. Clamping Action Turn-On: 37.1V
   6. Maximum Clamping (8x20 micro-seconds): 52V
   7. Maximum Surge Voltage: 6kV
   8. Maximum Surge Current (8x20 micro-seconds): 2.5kA
   9. Response Time: Less than 1 nanosecond
   10. Operating & Storage Temperature: -40 to 85 degrees C.

2.13 SURGE SUPPRESSOR - 120VAC/208VAC/480VAC POWER, PANEL MOUNTED

A. Manufacturer:
   1. Allen Bradley 4983-DS
   2. Or equal

B. Agency Approvals:
1. UL 1449
2. CSA C22.2 NO.8

C. General Description
1. Din Rail Mounted
2. Replaceable modules

D. Electrical:
1. 120,240V single phase
2. 208,480V three phase
3. Max continuous operating voltage: 150-400VAC
4. 40 kA current rating
5. 4 pole

2.14 TERMINAL BLOCK - INDICATING FUSED

A. Manufacturer:
1. Allen Bradley Bulletin 1492-H4 (AC) or 1492-H5 (DC)
2. Or equal

B. Agency Approvals:
1. UL
2. CSA
3. IEC

C. Specifications:
1. Voltage Rating: 300VAC/VDC
2. Maximum Current: 12A
3. Wire Range (Rated Cross Section): No.30 to no.12 AWG
4. Leakage Current:
   a. 2 mA at 300VAC
   b. 2 mA at 24VDC
5. Working Voltage:
   a. 100 to 300VAC
   b. 10 to 57VAC/VDC
6. Fuse Size: 1/4 in x 1-1/4 in
7. Wire Strip Length 0.38 in
8. Tightening Torque: 3 to 7 lb-in
9. Density: 33 pcs./ft
10. Insulation Temperature Range: -40 to 221 degrees F
11. Accessories:
    a. Aluminum DIN Rail with Standoff Brackets
    b. End Barrier and End Anchors
    c. Side Jumper Insulating Sleeve

d. Marking Systems

2.15 TERMINAL BLOCK - ISOLATING SWITCH

A. Manufacturer:
1. Allen Bradley Bulletin 1492-H7
2. Or equal

B. Agency Approvals:
1. UL
2. CSA
3. IEC

C. Specifications:
1. Voltage Rating: 300VAC/VDC
2. Maximum Current: 15A
3. Wire Range (Rated Cross Section): No.30 to No.12 AWG
4. Leakage Current:
   a. 2 mA at 300VAC
   b. 2 mA at 24VDC
5. Working Voltage:
   a. 100 to 300VAC
   b. 10 to 57VAC/VDC
6. Dummy Fuse Size: 1/4 in x 1-1/4 in
7. Wire Strip Length 0.38 in
8. Tightening Torque: 3 to 7 lb-in
9. Density: 33 pcs./ft
10. Insulation Temperature Range: -40 to 221 degrees F
11. Accessories:
    a. Aluminum DIN Rail with Standoff Brackets
    b. End Barrier and End Anchors
    c. Side Jumper Insulating Sleeve
    d. Marking Systems

2.16 TERMINAL BLOCK - OPEN STYLE

A. Manufacturer:
1. Allen Bradley ~~Bulletin 1492-CAM1~~
~~2. Or equal~~

B. Agency Approvals:
1. UL
2. CSA
3. IEC

C. Specifications:
1. Voltage Rating: 600VAC/VDC
2. Maximum Current: 65A
3. Wire Range (Rated Cross Section): No.22 to No.8 AWG
4. Wire Strip Length 0.38 in
5. Tightening Torque: 10 to 16 lb-in
6. Density: 30 pcs./ft
7. Insulation Temperature Range: -40 to 221 degrees F
8. Accessories:
a. Aluminum DIN Rail with Standoff Brackets
b. End Barrier and End Anchors
c. Side Jumper Insulating Sleeve
d. Marking Systems

D. Usage:
1. Allen Bradley Bulletin 1492-CAM1 for power terminal blocks
2. Allen Bradley Bulletin 1492-J4 for control wiring terminal blocks

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK (NOT USED)

3.02 FIELD MEASUREMENTS

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

3.03 DELIVERY STORAGE AND HANDLING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

3.04 INSTALLATION

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

3.05 TESTING AND START-UP SERVICES

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

3.06 TRAINING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation & Control.

END OF SECTION

SECTION 26 90 20

INSTRUMENTATION DEVICES

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. Applicable provisions of Part I shall govern the work of this section.

B. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
    a. ANSI/NFPA 70 - National Electrical Code (NEC) and state amendments thereto.
    b. ANSI/IEEE C37.90 - IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.
    c. ANSI/IEEE C62.11- IEEE Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits.
    d. ANSI/IEEE C62.34 - IEEE Standard for Performance of Low-Voltage Surge-Protective Devices (Secondary Arresters).
    e. ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. International Society of Automation (ISA)
6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition.
    a. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
    b. NEMA ICS 3 - Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC.

7. Underwriters' Laboratories, Inc. (UL), Specifications and Standards, current edition.
   a. UL508 - Industrial Control Equipment.
   b. UL508A - Industrial Control Panels.
   c. UL 913 - Intrinsically Safe Specification.
   d. UL94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
8. Wisconsin Department of Safety and Professional Services (DSPS)
9. National Electrical Contractors Association (NECA), current edition.
   a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
10. International Electrical Testing Association (NETA)
   a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
11. Canadian Standards Association (CSA), Specifications and Standards, current edition.
   a. CSA C22.2, Industrial Control Equipment.
12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
13. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.
   a. IEC 60529 - Classification of Degrees of Protection Provided by Enclosures
14. CE - European Community, Applicable Directives.
   a. EN50005 - for Terminal Markings.
   b. EN50081-1- Generic Emission Standard.
   c. EN50082-1 - Generic Immunity Standard.
   d. EN61000-4-4 - Electromagnetic compatibility (EMC). Testing and measurement techniques.
   e. EN61000-4-5 - Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test.

1.03 DESCRIPTION OF WORK

A. For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of:
   1. Section 26 90 00 - Process Instrumentation and Control.

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

1.05 SUBMITTALS

A. Submit shop drawings in accordance with Division 01.

B. Submit shop drawings for the equipment specified herein as part of the complete, integrated submittal for the process instrumentation & control system and in accordance with the requirements specified under Section 26 90 00 - Process Instrumentation and Control.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation & maintenance manuals and instructions in accordance with Division 01.

B. Submit operation and maintenance manuals for the equipment specified herein as part of the complete, integrated manual for the process instrumentation and control system and in accordance with the requirements specified under 26 90 00 - Process Instrumentation and Control.

1.07 FACTORY TESTING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

1.08 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.09 WARRANTY

A. See Division 01 for additional requirements.

1.10 EXTRA MATERIALS

A. See Division 01 for additional requirements.

1.11 MAINTENANCE

A. Before substantial completion, perform all maintenance activities required by any sections of the specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems into service.

B. Furnish all spare parts as required by other sections of the specifications.

PART 2 PRODUCTS AND MATERIALS

2.01 INSTRUMENTATION AND CONTROL DEVICES

INSTRUMENTATION AND CONTROL DEVICES			
TAG NUMBER	DESCRIPTION	CODE	NOTES
LSH-1-1	HIGH LEVEL ALARM	L2	
LSC-1-3	LAG PUMP START	L2	
LSC-1-2	LEAD PUMP START	L2	
LSC-1-1	PUMPS OFF	L2	
LSL-1-1	LOW LEVEL ALARM	L2	
~~ANT-6-1~~	~~ANTENNA~~	~~A1~~	
NOTES: CONTACTOR AND SYSTEM INTEGRATOR SHALL VERIFY SCHEDULE WITH PLANS.			

~~2.02 A1 YAGI ANTENNA~~

~~A. Yagi Directional Antenna - Remote Site~~

~~1. Manufacturer:~~
~~a. Kafhrein Inc. RY-900B.~~
~~b. Or equal~~
~~2. General:~~
~~a. Radome protected Yagi antenna.~~
~~b. Rugged fiberglass radome.~~
~~c. Radiator Material: 3/8 inch, solid 6061-T6 aluminum~~
~~d. Resistant to rain, snow, and ice.~~
~~e. Stainless steel hardware.~~
~~f. Internal connectors. Sealed with foam and potting system.~~
~~g. Capable of V&H polarization.~~
~~h. Lightning Protection: DC grounded~~
~~i. Wind Survival: 120 mph~~
~~j. Mounting Hardware: stainless steel, included~~
~~k. Factory assembled and tuned~~
~~3. Electrical Specifications~~
~~a. Frequency Range: 890-960 MHz~~
~~b. Factory Tuned Frequency: 898 MHz~~
~~c. Gain: 12dB~~
~~d. Bandwidth at 1.5:1 VSWR:~~
~~e. Maximum Power: 1000 watts~~
~~f. Horizontal Beam-width at 1/2 Power: 48 degrees~~
~~g. Vertical Beam-width at 1/2 Power: 40 degrees~~
~~h. Nominal Impedance: 50 Ohms~~
~~i. Front to Back Ratio: 20dB~~
~~j. Termination: N female~~
~~4. Mechanical Specifications~~
~~a. Weight: 16 lbs~~
~~b. Length: 29 inches ±~~
~~c. Height: 17 inches~~

~~B.~~

~~2.03~~2.02 L2 – LEVEL SWTICH, WET WELL FLOAT

A. Manufacturer
1. Cox Research, Model OPTI-F160 Float, Model OPTI-TR2 Transceiver

B. General:
1. The contractor shall furnish and install all float switches as shown on the drawings and as required for a complete and properly operating system. .

C. Reference:
1. NFPA 70 –National Electrical Code, National Fire Protection Association, Latest Edition. B.

2. U.L. 508 A – Industrial Control Panels, Underwriters Laboratories, Inc., Latest Edition.

D. Float switches and transceivers

1. The floats shall use fiber optic cable to transmit a beam of light from a transmitter in the control panel to the float where the beam makes and breaks depending on the tilt of the float. The receiver in the control panel shall detect the presence or absence of light and operate a relay in the receiver. The float shall have no electrical components or metallic wires that could cause arcs and sparks in an explosive atmosphere.
2. The float switch shall be mercury and lead free and shall be made of all safe, recyclable materials. The float switch housing shall be polypropylene. It shall be a simple robust device designed for many years of dependable service. The beam eclipser shall be stainless steel in an inert non-toxic dampening fluid that prevents chatter due to wave action. The viscosity of the fluid shall not change significantly over the range of –50 to +155F (-45 to +70C). The transceivers (transmitter and receiver combination) shall be dual din rail mounted units capable of connection to 2 floats. Provide one dual transceiver for every 2 floats. The fiber optic cable shall be custom made for the float and shall consist of dual plastic fibers with an overall specially blended PVC sheath for flexibility. No special tools or experience shall be required for connection of the optical cable to the transceivers. The cable shall be connected and sealed at the float housing using a double seal method that will prevent water from entering the float even if the outer sheath is damaged. The float color shall be two tone with the lighter color on the dome for easier viewing underwater when tilted up.
3. The transceivers shall operate in ambient temperatures of –15 to +130F (-25 to +55C). The transceivers shall operate at 12 VDC and shall be protected against accidental polarity reversal. The system shall operate in the visible and infrared light region with wavelengths between 400 and 1200 nm. The output relays in the receivers shall have the capability of being connected normally open or normally closed. The transceivers shall have a green led power-on light and red led lights on each channel indicating that the light beam is being received – float tilted up. The floats shall operate in liquid temperatures of +32 to +130F (0 to +55C). The floats shall have an ambient air standby operating temperature rating of –15 to +155C (-25 to +70C).
4. The float switches and transceivers shall be the Optical Float® level detection system by Cox Research and Technology, Inc., Baton Rouge, La. The dual transceivers shall be model TR2, and the floats shall be Opti-Float® model F

E. Accessories:

1. 30 foot stainless steel suspension kit including weight.
2. Universal attachment bracket OPTI-UAB1
3. (2) McMaster Carr model 3177T5 per float

~~2.04~~2.03 CONSTRUCTION METHODS

~~2.05~~2.04 DIVISION OF WORK (NOT USED)

~~2.06~~2.05 FIELD MEASUREMENTS

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

~~2.07~~2.06 DELIVERY STORAGE AND HANDLING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

~~2.08~~2.07 INSTALLATION

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

~~2.09~~2.08 TESTING AND START-UP SERVICES

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

~~2.10~~2.09 TRAINING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

END OF SECTION

SECTION 26 90 30

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 shall govern the work of this section.

B. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American National Standards Institute/National Fire Protection Agency (ANSI/NFPA), Specifications and Standards, current edition:
    a. ANSI/NFPA 70 - National Electrical Code and state amendments thereto.
    b. ANSI/IEEE C37.90 - IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
2. ASTM International (ASTM), originally known as the American Society for Testing and Materials, Specifications and Standards, current edition:
3. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE)
4. Insulated Cable Engineers Association (ICEA)
5. International Society of Automation (ISA)
6. National Electrical Manufacturers Association (NEMA), Specifications and Standards, current edition.
    a. NEMA ICS 2- Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
    b. NEMA ICS 3- Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC.
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    b. UL508A - Industrial Control Panels.
    c. UL94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

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    a. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting.
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    a. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
11. Canadian Standards Association (CSA), Specifications and Standards, current edition.
    a. CSA C22.2, Industrial Control Equipment.
12. Electrical and Electronic Manufacturers Association Canada (EEMAC), Specifications and Standards, Current Edition.
13. International Electrotechnical Association (IEC), Specifications and Standards, Current Edition.
    a. IEC1131-1. Programmable Controllers - Part 1: General Information.
    b. IEC1131-2. Programmable Controllers - Part 2: Equipment Requirements and Tests.
    c. IEC1131-3. Programmable Controllers - Part 3: Programming Languages.
    d. IEC1131-4. Programmable Controllers - Part 4: User Guidelines.
    e. IEC1131-5. Programmable Controllers - Part 5: Communications.
    f. IEC 60529 - Classification of Degrees of Protection Provided by Enclosures
14. CE - European Community, Applicable Directives:
    a. EN50005 - for Terminal Markings.
    b. EN50081-1- Generic Emission Standard.
    c. EN50082-1 - Generic Immunity Standard.
    d. EN61000-4-4 - Electromagnetic compatibility (EMC). Testing and measurement techniques.
    e. EN61000-4-5 - Electromagnetic compatibility (EMC). Testing and measurement techniques. Surge immunity test.

1.03 DESCRIPTION OF WORK

A. For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of:
    1. Section 26 90 00 - Process Instrumentation & Control

B. Equip programmable logic controllers with memory and functional capacity to perform the specified sequence of operation with the scheduled input and output points.

C. Equip programmable logic controller systems with I/O as scheduled on the drawings and necessary for the system to function as specified.

D. All PLC programming by owner.

1.04 RELATED WORK ELSEWHERE

A. Article 102 – Bidding Requirements and Conditions

B. Article 103 – Award and Execution of the Contract

C. Concrete – Division 03

D. Metals – Division 05

E. Electrical - Division 26

1.05 SUBMITTALS

A. Submit shop drawings in accordance with Division 01.

B. Submit shop drawings for the equipment specified herein as part of the complete, integrated submittal for the process instrumentation & control system and in accordance with the requirements specified under Section 26 90 00 - Process Instrumentation & Control.

C. Submit the following information specifically for programmable logic controllers:
   1. Software configuration consisting of data tables, ladder logic, and other parameters.
   2. Identify coordination requirements with other sections.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation & maintenance manuals and instructions in accordance with Division 01.

B. Submit operation and maintenance manuals for the equipment specified herein as part of the complete, integrated manual for the process instrumentation and control system and in accordance with the requirements specified under 26 90 00 - Process Instrumentation & Control.

C. Submit the following information specifically for programmable logic controllers:
   1. As-built printout of all software configuration including data tables, ladder logic, passwords, and other parameters. Document software with English language descriptions and tag numbers where appropriate.
   2. Electronic documentation shall include fully annotated electronic copies of all PLC programs. As-built documentation shall include all changes made during the first year of operation.
   3. Software configuration files shall be included in the manual in two forms:

a. CD ROM.
b. Paper.

D. Submit software license certificates, manufacturer provided software documentation, and software installation media.

1.07 FACTORY TESTING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

1.08 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.09 WARRANTY

A. See Division 01 for additional requirements.

1.10 EXTRA MATERIALS

A. See Division 01 for additional requirements.

B. Supply one spare 120VAC discrete input/output module of each type supplied for this project

C. Supply one spare 24VDC analog input/output module of each type supplied for this project

D. Supply one spare of each type of analog input/output module supplied for this project.

E. Supply one spare processor of each type supplied for this project

1.11 DESIGN REQUIREMENTS (NOT USED)

1.12 MAINTENANCE

A. Before substantial completion, perform all maintenance activities required by any sections of the specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems into service.

B. Furnish all spare parts as required by other sections of the specifications.

PART 2 PRODUCTS AND MATERIALS

2.01 MANUFACTURER

A. Acceptable Manufacturers:
   1. Allen-Bradley

2.02 PROGRAMMABLE LOGIC CONTROLLER SYSTEM, COMPACTLOGIX PLATFORM (EXPANDABLE)

A. Processor Unit
   1. Manufacturer:
      a. Allen-Bradley CompactLogix L30ER
   2. Processor requirements:
      a. Input Power: Supplied via chassis power supply module, 1769-PA2.
      b. Memory:
         1) User Memory: 1 Mbytes
         2) Memory Card: 1 Gbyte secure digital (SD) card
      c. Communication Ports:
         1) Two 10/100 Mbps Ethernet Port
            a) EtherNet/IP messaging only
         2) One built-in USB

B. Expansion I/O:
   1. Analog input module:
      a. Manufacturer: Allen-Bradley Model 1769-IF4I
      b. Input points: four isolated differential, individually selectable as current or voltage
   2. Analog output module:
      a. Manufacturer: Allen-Bradley Model 1769-OF4CI
      b. Output points: four isolated, individually selectable as current or voltage
   3. Digital Input:
      a. Allen-Bradley Model 1769-IA8I
      b. Voltage Category/Type: 100 to 120VAC

c. Operating Voltage: 79 to 132VAC
d. Signal Delay, Max.: On: 20.0 ms, Off: 20.0 ms
e. Off-State Current, Max.: 2.5 mA
f. IEC Input Compatibility: Type 1
g. Number of Inputs: 8 isolated
h. Bus Current Load, Max.: 115 mADC at 5VDC
i. Non-isolated input modules are acceptable for generator and ATS status inputs, 1769-IA16 and 1769-IQ16.

4. Digital output:
a. Manufacturer: Allen-Bradley Model 1769-OW8I
b. Operating Voltage: 5 to 265VAC
c. Continuous Current per Output, Max: 2.5A
d. Continuous Current per Module, Max: 20A
e. Number of Outputs: 8 isolated
f. Type of Contact Outputs: Normally open
g. Non-isolated output module, 1769-OW8 is acceptable for loads contained within control panel only.

5. RTD input module:
a. Manufacturer: Allen-Bradley Model 1769-IR6
1) Input points: six (0-3000Ω) resistive inputs

6. Thermocouple input module:
a. Manufacturer: Allen-Bradley Model 1762-IT6
1) Input points: four thermocouple inputs (Type J, K, T, E, R, S, B, N, C)

7. HART Capable analog input:
a. Manufacturer: Spectrum Controls Model 1769sc-IF4IH
1) Input points: four individually isolated HART protocol capable inputs

PART 3 CONSTRUCTION METHODS

3.01 DIVISION OF WORK (NOT USED)

3.02 FIELD MEASUREMENTS

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

3.03 DELIVERY STORAGE AND HANDLING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

3.04 INSTALLATION

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

B. Provide interconnect cables of the appropriate type as needed.

3.05 TESTING AND START-UP SERVICES

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

3.06 TRAINING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

END OF SECTION

SECTION 26 90 60

ETHERNET NETWORKING EQUIPMENT

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. Applicable provisions of Part I shall govern the work of this section.

B. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent applicable. The latest edition accepted by the Authority Having Jurisdiction of the referenced publications in effect at the time of the bid governs

1. American National Standards Institute/Instrument Society of America (ANSI/ISA), Specifications and Standards, Current Edition:
    a. ANSI/ISA-5.1-1984 - Instrumentation Symbols and Identification.
    b. ANSI/ISA-5.3-1983 - Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.
    c. ANSI/ISA-95.00.01-2000 - Enterprise Control System Integration, Part 1: Models and Terminology.
    d. ANSI/ISA-TR99.00.01-2004, Security Technologies for Manufacturing and Control Systems.
    e. ANSI/ISA-TR99.00.02-2004, Integrating Electronic Security into the Manufacturing and Control Systems Environment.
2. Telecommunications Industry Association (TIA), Electronic Industries Alliance (EIA), Specifications and Standards, current edition:
    a. TIA/EIA-568-A - Commercial Building Telecommunications Wiring.
    b. TIA/EIA-569-A - Commercial Building Standards for Telecommunications Pathways and Spaces.
    c. TIA/EIA-606 - Documentation.
    d. TIA/EIA-607 - Commercial Building Bonding and Grounding Requirements.
    e. TIA/EIA TSB-67 - Transmission Performance for Field Testing of Unshielded Twisted Pair Cabling Systems.
    f. TIA/EIA TSB-72 - Centralized Optical Fiber Cabling Guidelines.
    g. TIA/EIA-526-14 - Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant.

h. TIA/EIA-429-AAA - Detail Specification for 62.5 - UM Core Diameter/125-UM Platting Diameter Class 1A Multimode, Graded Index Optical Wave Guide Fibers.

1.03 DESCRIPTION OF WORK

A. For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of:
   1. Process Instrumentation and Control - Division 26

1.04 RELATED WORK ELSEWHERE

A. For the purpose of obtaining a complete and integrated process instrumentation and control system, the work specified herein shall be included under the scope of:

B. Article 102 – Bidding Requirements and Conditions

C. Article 103 – Award and Execution of the Contract

D. Concrete – Division 03

E. Metals – Division 05

F. Electrical - Division 26

1.05 Utilities – Division 33SUBMITTALS

A. Submit shop drawings in accordance with Division 01.

B. Submit shop drawings for the equipment specified herein as part of the complete, integrated submittal for the process instrumentation & control system and in accordance with the requirements specified under Section 26 90 00 - Process Instrumentation and Control.

C. Submit the following information specifically for Ethernet networking equipment:
   1. Literature sufficient in scope to demonstrate compliance with the requirements of this specification.
   2. Identify all software licensing requirements.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. Submit operation/maintenance manuals and instructions in accordance with Division 01.

B. Submit operation and maintenance manuals for the equipment specified herein as part of the complete, integrated manual for the process instrumentation and control system and in accordance with the requirements specified under 26 90 00 - Process Instrumentation & Control.

C. Submit the following information specifically for Industrial Ethernet Network:
   1. As-built printout of all software configuration including data tables, passwords, and other parameters.
   2. Connection diagrams for each individual piece of equipment.
   3. Complete riser diagram indicating all equipment and interconnecting components with indication of location of each device.
   4. Complete front elevation drawing of equipment rack and exact component layout within rack.
   5. Provide copy of written warranty.
   6. Complete test reports for fiber optic cable. Provide a fiber test form which includes the following:
      a. Date and time of:
         1) Fiber installation.
         2) Fiber termination.
         3) Testing.
      b. Testing equipment used information including:
         1) Make.
         2) Model.
         3) Date of calibration.
      c. Name of person performing test and the installers.
      d. dB loss of each connector installed.
      e. dB loss of each fiber segment.
      f. End to end attenuation.
      g. Optical Time Domaine Reflectometer (OTDR) Signature trace.
      h. Cable shall be tested at the following frequencies:
         1) 850 nm.
         2) 1300 nm.
   7. Complete test report for category 6 cabling. Provide test form which includes the following:
      a. Date and time of:
         1) Cable installation.
         2) Cable termination.
         3) Testing report.
      b. Testing equipment used information including:
         1) Make.
         2) Model.
         3) Date of calibration.
      c. Name of person performing test and the installers.
      d. Provide in spreadsheet format. Cable number with test reporting of cable length at near-end crosstalk and attenuation at frequency MHz at 1, 4, 10, 20 and 100. Also indicate room number of each jack.
   8. Submit software license certificates, manufacturer provided software documentation, and software installation media.

1.07 FACTORY TESTING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

1.08 QUALITY ASSURANCE

A. All materials, equipment, and parts shall be new and unused of current manufacture.

B. System supplier shall be responsible for providing all necessary accessories required for a complete and operable system.

C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

D. Products: Listed and classified by UL or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.09 WARRANTY

A. See Division 01 for additional requirements.

1.10 EXTRA MATERIALS

A. See Division 01 for additional requirements.

1.11 DESIGN REQUIREMENTS (NOT USED)

1.12 MAINTENANCE

A. Before substantial completion, perform all maintenance activities required by any sections of the specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems into service.

PART 2 PRODUCTS AND MATERIALS

2.01 INDUSTRIAL ETHERNET NETWORK SWITCH, 8-PORT

A. Manufacturer:
   1. Allen Bradley Stratix 2000

B. General
   1. Unmanaged Ethernet switch
   2. 8 ports minimum
   3. 25% spare ports minimum
   4. Din Rail Mount
   5. IEEE 802.3 Compliance

2.02 UTP CONTROL CABLE

A. Manufacturer:
~~1. Belden 7953A~~
~~2. Or equal.~~
1. Allen Bradley 1585 Ethernet Cable

B. General:
1. DataTuff 6
2. Bonded pairs
3. 600V rated cable
4. Industrial CAT 6
5. 23 AWG solid bare copper
6. Gigabit Ethernet
7. Shielded

PART 3 CONSTRUCTION METHODS

3.01 DIVISON OF WORK(NOT USED)

3.02 FIELD MEASUREMENTS

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

3.03 DELIVERY STORAGE AND HANDLING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

3.04 INSTALLATION

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

3.05 TESTING AND START-UP SERVICES

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

3.06 TRAINING

A. Refer to the requirements of Section 26 90 00 - Process Instrumentation and Control.

END OF SECTION

SECTION 31 05 19.13

GEOSYNTHETICS FOR EARTHWORK

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. Applicable provisions of Part I shall govern work of this section.

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, Current Edition.
2. State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction, Current Edition at time of bid opening.

1.03 DESCRIPTION OF WORK

A. The work under this section shall cover furnishing and installing geotextile fabrics for structural excavation and backfill of structures in accordance with the contract drawings and specified herein, and in accordance with Section 645 of the State of Wisconsin, Department of Transportation, Standard Specifications.

1.04 RELATED WORK ELSEWHERE

A. Packaged Sewage Lift Station – Division 33

B. Structural Excavation for Structures – Division 33

1.05 SUBMITTALS

A. Contractor shall submit such product literature and catalog cuts of materials to be supplied to relate these materials to the specifications. Information shall be in conformance with requirements of Submittals - Division 01 of these specifications.

B. The Contractor shall furnish to the Engineer at least ten days prior to use in the work a manufacturer's Certified Report of Test or Analysis that the geotextile fabric delivered for use conforms to this specification. The delivered geotextile fabric shall bear markings to clearly identify it with the applicable test report furnished to the Engineer.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

PART 2 PRODUCTS AND MATERIALS

2.01 GENERAL

A. The geotextile fabric shall consist of either woven or nonwoven polyester, polypropylene, stabilized nylon, polyethylene or polyvinylidene chloride. All fabric shall have the minimum strength values in the weakest principal direction. Nonwoven fabric may be needle punched, heat bonded, resin bonded, or combinations thereof.

B. The geotextile fabric shall be insect, rodent, mildew, and rot resistant.

C. The geotextile fabric shall be furnished in a wrapping which will protect the fabric from ultraviolet radiation and from abrasion due to shipping and hauling. The geotextile is to be kept dry until installed.

D. The geotextile fabric rolls shall be clearly marked showing the type of fabric.

E. Samples of fabric for testing may be obtained from the job site as specified herein or as determined by the Engineer.

F. If sewn seams are used, the Contractor shall furnish a field sewn seam sample produced from the geotextile fabric and thread and with the equipment to be used on the project, prior to its incorporation into the work.

G. All numerical values specified below represent minimum/maximum average roll values (i.e., the average of minimum test results on any roll in a lot should meet or exceed the minimum specified values).

2.02 GEOTEXTILE FABRIC

A. The fabric shall comply with the following physical properties:

Test	Method	Value
Grab Tensile Strength, lbs	ASTM D 4632	170 min.
Apparent Opening Size, U.S. Standard Sieve	ASTM D 4751	70 max.
Permittivity, SEC^{-1}	ASTM D 4491	0.35 min.

B. Acceptable materials are Geotex 701, Thrace-LINQ 160EX, Mirafi 170N, and US 180 NW, or equal.

PART 3 CONSTRUCTION METHODS

3.01 GENERAL

A. Installation procedures shall be in accordance with manufacturer's recommendations and as specified herein.

B. Sewing. All factory and field seams shall be sewn with a thread having the same or greater durability as the material in the fabric. A 401 stitch conforming to Federal Standard No. 751a shall be used for all seams. All seams shall develop a tensile strength equal to or greater than 60 percent of the specified grab tensile strength of the fabric, unless otherwise specified.

3.02 GEOTEXTILE FABRIC

A. Prior to the placement of the geotextile fabric, the subgrade shall be smoothed, shaped and compacted to the required grade, section, and density. After the fabric has been placed on the subgrade area, no traffic or construction equipment will be permitted to travel directly on the fabric.

B. The fabric shall be rolled out on the roadway and pulled taut manually to remove wrinkles. Separate pieces of fabric shall be joined by overlapping or sewing. The fabric in the overlapped joints shall be placed with a minimum overlap of 18 inches.

C. Weight or pins may be required to prevent lifting of the fabric by wind.

D. After placement, the fabric shall be exposed no longer than 48 hours prior to covering.

E. The base course material shall be placed over the fabric by back dumping with trucks and leveling with a crawler dozer. Construction equipment shall be such that ruts do not exceed 3 inches in depth. All ruts shall be filled with additional material. The smoothing of ruts without adding additional material will not be permitted. Damaged areas shall be covered with a patch of fabric using a 36 inch overlap in all directions.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Geosynthetics for earthworks shall be paid for at the bid price in accordance with one of the following methods, unless indicated otherwise in the Bid Schedule or Special Provisions.

B. All work specified herein shall be considered in each of the measurement and payment method(s) stipulated, unless indicated otherwise in the Bid Schedule or Special Provisions.

4.02 GEOTEXTILE FABRIC

A. Geotextile Fabric, Inclusive. Geotextile fabric related to the Lift Station as shown on the contract drawings and as outlined in the Project Manual shall be considered inclusive to payment for work associated with the Lift Station, per Lump Sum.

END OF SECTION

SECTION 31 23 16.16

STRUCTURAL EXCAVATION FOR STRUCTURES

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. Applicable Provisions of Part I shall govern work of this section.

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards, Current Edition.
2. Code of Federal Regulations (CFR), Title 29, Chapter XVII - Occupational Safety and Health Administration (OSHA), Department of Labor - Part 1926 Regulations, Current Edition.
3. State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction, Current Edition at time of bid opening.

1.03 DESCRIPTION OF WORK

A. The work under this section shall include all excavation, backfill and compaction for structures and other miscellaneous excavation, backfill and compaction required but not designated under other sections.

1.04 RELATED WORK ELSEWHERE

A. Part II – Earthwork and Miscellaneous Construction

B. Part V – Sewers and Sewer Structures

C. Packaged Sewage Lift Station – Division 33

1.05 SUBMITTALS (NONE)

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS (NONE)

PART 2 PRODUCTS AND MATERIALS

2.01 INSITU BACKFILL MATERIAL

A. Previously excavated soil or material free of organic debris, clay balls, and aggregate larger than 1-1/2 inches as approved by the Engineer.

2.02 IMPORTED GRANULAR FILL AND GRANULAR FOUNDATION

A. Imported granular fill and granular foundation shall be sand conforming to State of Wisconsin, Department of Transportation, Standard Specifications Section 209.2.2, Grade No. 1 Granular Backfill or well-graded sand and gravel conforming to State of Wisconsin, Department of Transportation, Standard Specifications Section 305.2.2.1 1-1/4 inch dense graded base with not more than eight percent (8 percent) by weight passing a No. 200 sieve.

PART 3 CONSTRUCTION METHODS

3.01 BARRICADES

A. Provide sufficient barricades and protective devices adjacent to excavations to safeguard against injury. Provide and maintain sufficient safety lanterns at walks, roadways and parking areas to provide safety at night.

3.02 EXCESS MATERIAL

A. To the extent needed, all suitable excavated materials shall be used for foundation backfill and site grading. The suitability of materials for specific purposes shall be determined by the Engineer. All surplus or unsuitable excavated materials will be designated as waste and used only for site grading or be disposed of by the Contractor.

3.03 EXCAVATION

A. All structural excavation shall be in accordance with the Geotechnical Investigations & Reports included within the Contract Documents.

B. Excavate to achieve necessary dimensions, lines, grades and cross sections. Notify the Engineer of any remaining pockets of organic or unsuitable soil, debris, existing foundations or poorly compacted fill soils. Unsuitable materials shall be removed and replaced with compacted granular fill or backfill material. Bottoms of trenches shall be excavated to proper grade so that structures will be supported on a firm bed of undisturbed natural earth or suitable, compacted backfill.

C. The required minimum soil bearing capacities for the new structures shall be as shown in the Contract Drawings, or as listed in the geotechnical report, whichever value is greater.

D. At all times when active excavation, backfilling, or other construction work is occurring in the excavations, and lasting until these activities are completed and accepted, ample means and equipment shall be provided with which to remove promptly, and dispose of properly, all water entering any excavation or other parts of the work. The excavations shall be kept dry and groundwater levels shall be kept at a minimum of 2-feet below the bottom of all excavations to prevent a quicksand condition in the excavation bottom.

E. All hardpan, stiff soils, and boulders encountered shall be included in the Work specified by this Section. See geotechnical report for further information. It shall be the responsibility of the Contractor to familiarize himself with the subsurface conditions on-site before submitting his bid.

3.04 UNAUTHORIZED EXCAVATION

A. Consists of removal of materials beyond indicated elevations or dimensions without specific direction of the Engineer. Notify the Engineer when unauthorized excavations are made.

3.05 STABILITY OF EXCAVATION

A. Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Provide shoring and bracing to retain banks and prevent collapse of excavations as necessary to safeguard workmen, prevent movement of adjacent ground, and avoid damage to existing improvements.

B. Means and methods of excavation are the responsibility of the Contractor including dewatering and earth retention systems. See geotechnical report for additional considerations.

3.06 COLD WEATHER PROTECTION

A. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees Fahrenheit.

3.07 BACKFILLING AND COMPACTION

A. Fill activities shall be in accordance with the Geotechnical Investigations & Reports included in the Contract Documents.

B. Place backfill to bring excavations to natural grade unless otherwise noted. Backfill within foundation walls and outside foundation walls to a distance of 10 feet outside

the building line and under pavements and walks shall be spread and compacted uniformly in 6 inch to 8 inch lifts to at least 95 percent maximum dry density per modified proctor (ASTM D1557).

C. Place and compact granular fill from the specified over-excavation elevation as shown on the Drawings, or as required by the Geotechnical Engineer, in 8-inch lifts to 95% maximum dry density per modified proctor (ASTM D1557) up to the elevation of the recommended geotextile wrapped, coarse crushed stone layer.

D. Site backfill placed outside a distance 10 feet from the building line shall be spread uniformly in 12 inch maximum lifts and trench backfill and similar work shall be with approved excavated material or granular backfill compacted in 8 inch maximum lifts to 93 percent dry density per modified proctor (ASTM D1557).

E. Backfill shall not be placed against any concrete structure which retains earth until the concrete has been in place 14 days or until test cylinders show the concrete strength to be at least 3000 pounds per square inch, nor shall high-early-strength concrete structures be backfilled before 6 days after the day of pouring or until test cylinders show the strength of the concrete to be at least 3000 pounds per square inch. Concrete structures which have earth on both sides (i.e., footings, frost walls, etc.), may be backfilled uniformly on both sides after the concrete has been in place 4 days, or 2 days for high-early-strength concrete. In no case shall backfilling start before required curing and protection, surface finishing, dampproofing, and waterproofing of the work to be covered by backfilling has been completed. When so permitted by the Engineer, footings may be backfilled uniformly on all sides to the top of such footing immediately upon removal of forms.

F. Contractor shall provide all necessary equipment required to obtain specified compaction. Compaction by travel of grading equipment is not considered adequate for uniform compaction. Small vibratory compactors are required wherever fill is placed adjacent to structures, foundation walls, footings and piers.

G. Backfilling shall be so performed as to prevent wedging action against the structure. Slopes within ten feet of the structure shall be stepped, terraced, or otherwise treated as necessary to prevent slippage and wedging of the backfill.

H. Water shall not be used to expedite settlement of the backfill except to adjust moisture content to optimize compaction. The groundwater level shall be kept below the level of the lift of material being compacted.

3.08 SAMPLING

A. All required sampling, preparing of specimens, and testing except as modified by these specifications shall be performed by an independent laboratory and paid for by

the Owner. The laboratory shall meet the requirements of ASTM E329. The Engineer shall determine when compaction tests shall be made.

3.09 TESTING

A. Any testing required because of failure of backfill to meet specification requirements shall be paid for by the Contractor.

PART 4 MEASUREMENT AND PAYMENT

4.01 GENERAL

A. Structural excavation, backfilling and compaction shall be paid for at the bid price in accordance with one of the following methods, unless indicated otherwise in the Bid Schedule or Special Provisions.

B. All work specified herein shall be considered in each of the measurement and payment method(s) stipulated, unless indicated otherwise in the Bid Schedule or Special Provisions.

4.02 STRUCTURAL EXCAVATION FOR STRUCTURES

A. Structural Excavation for Structures, Inclusive. Structural excavation for structures related to the Lift Station as shown on the contract drawings and as outlined in the Project Manual shall be considered inclusive to payment for work associated with Sanitary Sewer Lift Station, per Lump Sum.

4.03 IMPORTED GRANULAR FILL AND GRANULAR FOUNDATION

A. Imported Granular Fill and Granular Foundation, Inclusive Imported granular fill and granular foundation related to the Lift Station as shown on the contract drawings and as outlined in the Project Manual shall be considered inclusive to payment for work associated with Sanitary Sewer Lift Station, per Lump Sum..

END OF SECTION

SECTION 33 32 13.15

PACKAGED SUBMERSIBLE LIFT STATION

PART 1 GENERAL

1.01 APPLICABLE PROVISIONS

A. Applicable provisions of Division 01 and City of Madison Standard Specifications shall govern work of this section.

1.02 APPLICABLE PUBLICATIONS

A. The following publications of the issues listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the reference thereto.

1. American National Standards Institute (ANSI)
    a. ANSI B16.1 – Standard Specification for 125 lb. Standard Flat Face Cast Iron Flanges
    b. ANSI/AWWA C115/ A21.15 - Standard for Flanged Ductile-Iron Pipe With Threaded Flanges
    c. ANSI/AWWA C111/ A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
    d. ANSI/ AWWA C110/A21.10 - American National Standard for Ductile-Iron and Gray-Iron Fittings for Water
    e. ANSI/AWWA C104/A21.04 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
2. American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards:
    a. ASTM A36 - Specification for Structural Steel, Current Edition
    b. ASTM A48 - Standard Specification for Gray Iron Castings
    c. ASTM A126 -Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
    d. ASTM A743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
    e. ASTM D883 – Definitions of Terms Relating to Plastics
    f. ASTM D3753 – Standard Specification for Glass-Fiber-Reinforced Polyester Manholes
3. American Water Works Association (AWWA), Specifications and Standards, Current Edition.
    a. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances
4. American Welding Society (AWS), Specifications and Standards, Current Edition.
5. Code of Federal Regulations (CFR), Title 29, Chapter XVII - Occupational Safety and Health Administration (OSHA), Department of Labor, Part 1926 Regulations, Current Edition.

6. Federal Communications Council (FCC), Specifications and Standards, Current Edition.
7. National Electric Code (NEC), Specifications and Standards, Current Edition.
8. National Electrical Manufacturers Associations (NEMA), Specifications and Standards, Current Edition.
9. State of Wisconsin Administrative Code, Department of Natural Resources Environment Protection General:
   a. NR 110 - Sewage Systems, Current Edition.
10. Steel Structures Painting Council (SSPC), Specifications and Standards, Current Edition.

1.03 DESCRIPTION OF WORK

A. The Contractor shall furnish and install a factory built packaged submersible wastewater pumping station complete with all equipment installed in a wet well with integral valve vault, pumps, piping, valves, supports, vent, access covers, and accessories. The work shall include all labor and materials to provide a complete operating lift station to the Owner. Refer to drawings for additional information.

B. Valves and other appurtenances identified as part of the proposed forcemain shall comply with the Section.

C. The station shall be the product of a manufacturer who is experienced, skilled and regularly engaged in the design and fabrication of this type of equipment. The general design of the station shall be such that all working parts are readily accessible for inspection and repairs, easily duplicated and replaced, and each and every component suitable for the service required. The lift station shall be in conformance with all requirements of local, state, and federal agencies, and all applicable industry codes. In order to receive consideration, the manufacturer shall submit full descriptive material on the proposed equipment, including detailed structural and equipment specifications, dimension prints, pump performance curves, wiring diagrams and operational data, local service facilities, and list of installations in the State of Wisconsin. The manufacturer must clearly state or show any exceptions taken to the contract drawings and specifications.

D. The packaged submersible lift station shall be designed for Class 1, Groups C and D, Division 1 hazardous locations as defined by the National Electric Code.

E. The section includes coordination with electrical contractor to ensure the proper installation of electrical power and control system. Additional costs due to inadequate coordination as required herein shall be borne solely by the Contractor.

1.04 RELATED WORK ELSEWHERE

A. Part I – General Conditions

B. Part V – Sewers and Sewer Structures

C. Division 05 - Metals

D. Division 26 - Electrical

1.05 SUBMITTALS

A. The Contractor shall submit such Submittals and/or catalog cuts required for the construction and installation of the equipment. These drawings shall be accurate in every detail and shall contain all information necessary to relate the equipment to the specifications.

B. The Contractor shall provide a list, catalog cuts and descriptive information of all instrumentation and control equipment components to be provided with the Package Lift Station.

C. Submittals shall indicate the intended equipment arrangement, major support requirements, plot area, and process flow.

D. Submittals shall be submitted which indicate the internal control schematics and remote equipment, such as motor starters, flowmeters, etc. Submittals shall be submitted which indicate equipment and terminal block layout for interconnections to remote equipment.

1.06 OPERATION/MAINTENANCE MANUALS AND INSTRUCTIONS

A. The manuals shall include operating and maintenance literature for all components provided. The submitted literature shall be in sufficient detail to allow for the installation, operation, adjustment, calibration, maintenance and removal of each component provided.

B. Preparation of this document shall be in conformance with the Submittal requirements specified herein. The Contractor shall submit to the Engineer for review, an outline of any variations of information for the operation and maintenance manuals and other documentation he proposes to prepare.

PART 2 PRODUCTS AND MATERIALS

2.01 MANUFACTURER

A. The packaged submersible lift station shall be as manufactured by Topp Industries, Inc. and shall include pump equipment specified herein as manufactured by Xylem, Inc. or Fairbanks Morse Corporation.

B. The specifications and physical layout shown on the drawings are based Topp Industries and Xylem, Inc. equipment.

2.02 FIBERGLASS (FRP) STATION STRUCTURE

A. Materials: Fiberglass Reinforced Polyester Wet Well (and Integral Valvebox): Unless otherwise indicated the plastic terminology used in this specification shall be in accordance with the definitions given in American Society for Testing and Materials (ASTM) designations D883 - Definitions of Terms Relating to Plastics.

B. Resins: The resins used shall be a commercial grade polyester and shall be evaluated as a laminate by test or determined by previous service to be acceptable for the intended environment. The resins used may contain the minimum amount of fillers or additives required to improve handling properties. Up to 5% by weight of thixotropic agent, which will not interfere with visual inspection, may be added to the resin for viscosity control. Resins may contain pigments and dyes by agreement between manufacturer and engineer, recognizing that such additives may interfere with visual inspection of FRP laminate quality

C. Reinforced Material: The reinforcing material shall be a commercial grade of glass fiber (continuous strand, chopped-strand, continuous mat and non-continuous mat) having a coupling agent, which will provide a suitable bond between the glass reinforcement material and resin. Pump chamber shall be completely vapor sealed from wetwell.

D. Laminate Structure: The FRP laminate shall consist of a resin rich inner surface: chop-spray interior liner; and, a chop-hoop filamentwound structural exterior layer.

1. Inner surface:
    a. The resin rich inner surface shall be free of cracks and crazing with smooth finish and with an average of not over two (2) pits per square foot, providing the pits are less than 0.125 inches in diameter and 0.3125 inches in depth and are covered with sufficient resin to avoid exposure of any fiberglass reinforcement material. Some waviness shall be permissible as long as the surface is smooth. Between 0.01 to 0.02 inches of resin, rich surface shall be provided.
    b. Chop-Spray Interior Liner: The interior liner shall be reinforced by 25 to 35% by weight of chopped strand glass fiber having fiber lengths from 0.5 to 2.0 inches. The chop-spray interior liner protects the chop-hoop filament-wound structural exterior liner from corrosion damage caused by “wicking” of the wet well liquid contents. A minimum of 0.100 inches of chop-spray interior liner shall be provided.
    c. Chop-Hoop Filament-Wound Structural Exterior Layer:
        1) The structural reinforcement of the wet well shall be by the chop-hoop filament-wound manufacturing method only. The axial reinforcement shall be continuous-strand glass fiber. The longitudinal reinforcement shall be chopped-strand glass fiber. The glass fiber reinforcement content of the chop-hoop filament wound structural exterior layer shall be 50 to 80% by

weight. The exterior surface of the wet well shall be relatively smooth with no exposed reinforcement fibers or sharp projections. Hand finish work is permissible to prevent reinforcement fiber exposure. The wall thickness of the chop-hoop filament-wound structural exterior layer shall vary with the wet well height to provide the aggregate strength necessary to meet the tensile and flexural physical properties requirements.

E. Physical Properties: Wet Well FRP Wall Laminate: The wet well FRP wall laminate must be designed to withstand wall collapse or buckling based on the following assumptions and third party specifications:

1. Hydrostatic Pressure of 62.4 lbs. per square foot
2. Saturated soil weight of 120 lbs. per cubic foot
3. Soil Modulus of 700 pounds per square foot
4. Pipe stiffness values as specified in ASTM D3753

The wet well FRP laminate must be constructed to withstand or exceed two times the assumed loading on any depth of the wet well.

F. Wet Well FRP Bottom Laminate: The wet well FRP bottom laminate shall have less than 0.375 inches of center elastic deflection (deformation) when in service in totally submerged conditions.

G. FRP Laminate Surface Hardness: The finished FRP laminate will have a Barcol Hardness of at least 90% of the resin manufacturer's specified hardness for the fully cured resin. The Barcol Hardness shall be the same for both interior and exterior surfaces.

H. Wet Well Top Flange: The wet well top flange shall have an outside diameter at least 4.0 inches greater than the inside diameter of the well. A six-hole pattern shall accommodate the mounting of a cover with at least 0.375 inches in diameter 300 series stainless steel fasteners. Non-corroding stainless steel threaded inserts shall be fully encapsulated with noncontinuous mat or chopped-strand glass fiber reinforcement. The inserts shall have an offset tab to prevent stripping or spinning out when removing and reinserting cover fasteners.

I. Steel Anti-Floatation Flange: The steel anti-floatation flange shall be constructed from 0.1875 inches thick ASTM A36 structural steel plate, encapsulated in at least 0.125 inches of chopped-strand glass fiber reinforcement on all sides. The steel antifloatation flange shall be square with outside dimensions of at least 4.0 inches greater than the wet well inside diameter. The steel anti-floatation flange shall be attached to the wet well bottom with chopped-strand glass fiber reinforcement. Contractor shall place the wet well on a concrete pad and fill with grout covering the entire steel anti-floatation flange. The amount of grout shall be sufficient to prevent floatation of the wet well based on the jobsite conditions. The steel anti-floatation flange shall not require bolt holes to secure it to the concrete pad.

J. Inlet and Discharge Coupling: A sufficient quantity and type of "Link-Seal" type modular, mechanical, inter-locking, synthetic rubber links shaped to continuously fill the annular space between the discharge pipe and the aluminum sleeve shall be used to provide a hydrostatic seal. The aluminum sleeve shall be bolted on the wet well or valvebox wall and sealed with silicone sealer.

K. Electrical Coupling: A 304 stainless steel NPT full coupling shall be factory installed with at least 0.375 inches in diameter 300 series stainless steel fasteners. The wet well wall penetrations shall be sealed with silicone sealer.

L. Float and Level Transducer Bracket: Bracket shall be fabricated from 300 series stainless steel with compression style cord grips to maintain float and transducer level positions. It shall be factory installed with at least 0.375 inches in diameter 300 series stainless steel fasteners. The wet well wall penetrations shall be sealed with silicone sealer.

M. Access Covers:

1. Wet well and integral valvebox covers shall be constructed of 0.250 inches thick mill finish aluminum diamond plate with 300 series stainless steel hardware. The access hatch shall have a recessed handle and locking pin. The hatch shall be held open in the vertical position by means of a hold open arm of corrosion resistant design. Covers shall be mounted to the wet well and integral valvebox with a least six 300 series stainless steel fasteners of at least 0.375 inches in diameter.
2. Doors shall be provided with stainless steel hinges with tamper-proof fasteners. Doors shall be provided with an aluminum lifting handle, and stainless steel locking bar, or stainless steel snap-lock with removable key handle.
3. Doors furnished with a frame drain shall have drain piping supplied by contractor to a suitable location as indicated by the Engineer.
4. When closed the door and all accessories shall provide a smooth surface.
5. Access lids for pad lock enclosure shall be secured in the flush position.
6. The door shall have a continuous EPDM debris gasket between door and frame.
7. Doors shall be single leaf, as required by pump manufacturer.
8. Each door shall be provided with fall protection. Secondary grating shall be provided below access cover.
    a. Grating made from aluminum or fiberglass designed to support a live load of 300 PSF. Grate shall be hinged to frame with stainless steel hinges and a hold arm capable of holding grate in the fully open 90-degree position. Stainless steel lifting assists and padlock-able hasp required.
    b. Grating shall allow for access of sewer cleaning equipment. This access shall consist of a 4" slot between fall protection grating and the hatch frame or provide a minimum of two 4-inch by 4-inch

banded opening within the grating. Maximum allowable opening between hatch frame and grating is 6”

9. A warning sign shall be attached to each door cover reading the following: “CAUTION - Confined Space: Dangerous/hazardous gases. Do not enter without proper equipment and supervision.”

N. Valve Vault Access Ladder:

1. Fabricate ladder of Aluminum (ASTM B221, alloy 6063-T6) to dimensions coordinated with pre-fabricated vessel manufacturer.
2. Ladders shall conform to the requirements of 29 CFR Chapter XVII, Part 1926 OSHA 1926.450 and meet the loading and configuration requirements of the “Safety Code for Fixed Ladders”, ANSI A14.3-56.
3. Side rails: continuous ½ by 2 ½ inch aluminum flat bars, with eased edges, spaced 18 inches apart.
4. Bar rungs: ¾ inch minimum diameter aluminum bars, spaced 12 inches on center. Fit rungs in centerline of side rails; plug-weld and grind smooth on outer rail faces. Each run must support a load of at least 250 lbs. applied in the middle of the rung.
5. Support each ladder top and bottom and not more than 60 inches on center with welded or bolted aluminum brackets. Size brackets to support design loads specified in OSHA Standard 1917.118 and ANSI A14.3. The support brackets shall be length such that minim distance between the rung and center line and the nearest permanent object behind the rung is 7 inches.
6. Provide corrugated, knurled, or dimpled rungs or provide non-slip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
7. Furnish & install below hatch cover, LadderUP safety post Model LU-4 as manufactured by The Bilco Company or approved equal. Device shall be aluminum with mill finish. It shall be designed with telescoping tubular section that locks automatically when fully extended. Upward and downward movement shall be controlled by a stainless steel spring balancing mechanism. Unit shall be completely assembled with fasteners for securing to the ladder rungs in accordance with the manufacturers instructions.

O. Vent: Provide 4-inch diameter stainless steel vent with insect screen and weatherhood.

2.03 PUMPS

A. The system shall be designed to permit surface level removal of the pumping unit for inspection or service without dewatering the pump chamber or interrupting operation of the other units in the pumping system. The pumps, when lowered into place, shall automatically connect to the discharge piping with a positive action.

B. Submersible pumps shall be manufactured by Xylem-Flygt or Fairbanks-Nijhuis.

C. The specifications and physical layout shown on the drawings are based upon Topp Industries Lift Station and Xylem-Flygt pumping system.

D. Operating Criteria: Each pump shall meet or exceed design pumping conditions as follows:

Pump Application	Municipal Wastewater			
Pump Location	Lift Station			
Model#:	Flygt Model NP3102 SH			
	Fairbanks Model 5432MVK			
Quantity of Pumps	Two (2)			
Discharge Size:	4-inch			
Design Points	Condition	Flow (gpm)	TDH (ft.)	Eff. (%)
	#1	100	29	39
	#2	140	24	45
	#3	200	16	53
Minimum Shutoff Head	33 feet			
Pump Speed	1750 RPM max.			
Maximum Motor HP	Five (5)			

Each unit shall produce the specified flow at given head, a minimum efficiency, and maximum speed for each operating condition specified above.

E. Each pump shall be designed for pumping storm water/raw sewage/septic effluent.

F. The pump shall be non-overloading throughout the entire range of operation without employing service factor. The pump shall reserve a minimum service factor of 1.15. The performance curve submitted for approval shall state in addition to head and capacity performance, the pump efficiency, pump speed, solids handling capacity and reflect motor service factor.

G. Pump Construction:

1. Pump volute shall be single piece, gray iron ASTM A48, Class 30 with smooth internal surfaces free of rough spots, gas holes, or flashing. Scroll type volute design which tends to unbalance from wear resulting in shaft stress shall not be considered equal or acceptable. All exposed nuts or bolts shall be AISI Grade 304 stainless steel or brass construction. All metal surfaces coming into contact with the liquid, other than stainless steel or brass, shall be protected by a factory applied spray coating of alkyd primer with a chlorinated rubber paint finish on the exterior of the pump.

2. Pump shall be automatically and firmly connected to the discharge. Sealing of the pump to the discharge connection shall be accomplished by a machined metal-to-metal watertight contact. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Fittings will be the result of controlled compression of

rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit. Rectangular cross-sectioned gaskets requiring specific torque limits to achieve compression shall not be considered adequate or equal. No secondary sealing compounds, grease or other devices shall be used. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. No portion of the pump shall bear directly on the sump floor.

3. The solid handling type impeller shall be gray iron, ASTM A48, Class 30, dynamically-balanced, double-shrouded non-clogging design having a long through let without acute turns. The impeller shall be one or two vane fully enclosed and the nose of the impeller shall extend into the volute so that the diameter may be trimmed to meet various Special Procedures of head and capacity while still retaining the factory balance. All impellers shall have pump out vanes on the back shroud. Mass moment of inertia calculations shall be provided by the pump manufacturer upon request. All impellers shall be retained with an allen head bolt and shall be capable of passing a 3 inch solid. All impellers shall be coated with alkyd resin primer.

4. A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impellers. The wear ring shall be stationary and made of brass, which is drive fitted to the volute inlet.

5. Pump and motor shaft shall be the same unit. The pump shaft shall be an extension of the motor shaft. Couplings shall not be acceptable. The pump shaft shall be AISI Grade 304 stainless steel.

H. Motors:

1. The submersible pump shall be driven by a completely sealed electric submersible motor of 5 horsepower, 1.15 service factor, 1750 rpm, for operation on 208 volts, 3 phase power. The motor nameplate horsepower rating shall not be exceeded by the brake horsepower requirements of the pump for the specified head and GPM conditions.

2. The submersible pump motor shall be designed for a Class 1 Groups C and D, Division 01 hazardous location as defined by the National Electric Code. The motor shall be listed with Underwriters Laboratories as Class 1, Groups C and D, Division 01, explosion-proof, for installation in water or sewage. The motor shall be housed in an air filled, watertight chamber, NEMA B rated. The stator winding and stator leads shall be insulated with moisture resistant Class F insulation rated for 311 degrees F (155 degrees C). The stator shall be dipped and baked with Class F varnish and shall be heat-shrink fitted to the stator housing. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable.

3. The motor shall be designed for continuous duty handling liquid media of 104 degrees F (40 degrees C) and capable of up to 15 starts per hour. The rotor bars and short circuit rings shall be a made of cast aluminum. Thermal switches set to open at 260 degrees F (125 degrees C) shall be embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel.

4. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10 percent. The motor shall be designed for operation up to 104 degrees F (40 degrees C) ambient and with a temperature rise up to 176 degrees F (80 degrees C). A performance chart shall be provided showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.

5. The motor shaft shall be stainless steel, impervious to the liquid and waste materials being handled. All external hardware including the motor nameplate shall also be made of stainless steel.

6. The pump shall be provided with an oil chamber for the shaft sealing system. The oil chamber shall be designed to prevent overfilling and to provide oil expansion capacity. The drain and inspection plug with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped liquid for lubrication. The motor shall be capable of operating dry without damage while pumping under load.

    a. Tandem mechanical shaft seal system consisting of two independent seal assemblies, inside an oil chamber that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the oil chamber, shall contain one stationary and one positively driven rotating tungsten carbide ring. The upper secondary seal unit, located between the oil chamber and the motor housing, shall contain one stationary ceramic seal ring and one positively driven rotating carbon seal ring. Each seal interface shall be held in contact by its own ring system. The seals shall require neither maintenance nor adjustment nor depend on the direction of rotation for sealing, and one outside shall provide double protection for the electrical parts. Two moisture-sensing probes shall be used to detect any influx of conductive liquid past the outer seal and provide ample warning of first seal failure.

b. Shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces. Cartridge type systems will not be acceptable. No system requiring a pressure differential to offset pressure and to effect sealing shall be used.

7. Motor bearings shall be permanently pre-lubricated at the factory. The upper bearing shall be a single groove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces.

8. Motor winding shall have a special Class F insulation system providing 1.15 service factor and extended life. Automatic reset, normally closed thermal overloads shall be installed in adjacent phases of the motor winding to provide the overheating protection.

9. The stator shall be securely held in place with a removable end ring and threaded fasteners so that it may be easily removed. Pumps that require the stator to be removed using heat or press fit are not considered acceptable. Air filled motors that require additional external cooling methods are also not considered acceptable. The pumps are to be explosion-proof and meet all requirements for Class I, Group D, Division I hazardous location.

I. Power Cord:

1. Electrical power cord shall be sized per the NEC and ICEA standards and shall have sufficient length to reach the junction box without splices. Electrical power cord shall have an outer jacket which is resistant to oil and other materials normally found in sewage. Power cord is to be sealed, not only by use of a cord grip, but shall have individual conductors sealed into the cord cap assembly with epoxy sealing compound. The epoxy seal shall be repeated where the conductors enter the motor from the connection box which is mounted on top of the motor housing. The cord cap and connection box shall be sealed with an O-ring. Power cord shall run continuously from motor to control panel.

2. Power cord shall run continuously from motor to control panel.

J. Seal Sensor:

1. A leakage seal sensor shall be provide to sense water in the stator chamber shall be fitted with a float switch. When activated, the Float Leakage Sensor (FLS) shall stop the motor and send an alarm. The use of voltage sensitive solid-state sensors shall not be acceptable. A separate or panel mounted alarm shall be supplied to indicate water in the sealed chamber.

K. Heat Sensor:

1. All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. At 260 degrees F (125 degrees C) the thermal switches shall open, stop the motor and activate an alarm. The use of voltage sensitive solid-state sensors and trip temperature above 260 degrees F (125 degrees C) shall not be acceptable. A separate or panel mounted alarm shall be supplied to indicate pump overheating.

L. Factory Testing:

1. Commercial testing shall be required and include the following:
   a. The pump shall be visually inspected to confirm that it is built in accordance with the specification as to HP, voltage, phase, and hertz.
   b. The motor seal and housing chambers shall be Megger-ed for infinity to test for moisture content or insulation defects.
   c. Pump shall be allowed to run dry to check for proper rotation.
   d. Discharge pipe shall be attached, the pump submerged in water, and amp readings shall be taken in each leg to check for an imbalanced stator winding. If there is a significant difference in readings, the stator windings shall be checked with a bridge to determine if an unbalanced resistance exists. If so, the stator shall be replaced.
   e. The pump shall be removed from the water, Megger-ed again, dried and the motor housing filled with dielectric oil.
2. In addition to the above commercial testing, a special megger test shall be performed and include the following:
   a. The pump shall be submerged in water and allowed to run at maximum load for 30 minutes.
   b. A written report on the above shall be prepared by the test engineer, certified, and submitted to the Engineer.
3. A hydrostatic test shall also be performed on the pump. The hydrostatic test shall require that the volute and impeller be removed and a fixture installed to hold the spring and lower mechanical seal in place. A double plate, gasket, and through-bolt shall be installed on the pump. A discharge mating flange, gasket and pressure fitting shall be installed. The inlet port, volute, and discharge nozzle shall then be pressurized with water to 150 percent of the maximum pump shut off pressure. This hydrostatic pressure shall be maintained for at least 5 minutes and the housing checked for leaks and/or loss of pressure.
4. A non-witnessed Hydraulic Institute performance test shall be performed. This shall include the following:
   a. The pump shall be tested at the design point as well as at least four other points to develop a curve. Data shall be collected to plot the head-capacity curve as well as a KW input and amperage curve.
   b. In making these tests, no minus tolerance or margin shall be allowed with respect to capacity, total head, or efficiency at the specified design condition. Pump shall be held within a tolerance of 10 percent of rated capacity or at rated capacity with a tolerance of 5 percent of rated head. The pump shall be tested at shut-off but not be plotted

and only used as a reference point when plotting the performance curve.

c. Complete records shall be kept of all information relevant to the test as well as the manufacturer's serial number, type and size of pump as well as any impeller modifications made to meet the design conditions.

d. A written test report shall be prepared, signed and dated by the test engineer, incorporating three curves (head-capacity, KW input, and amperage) along with the pump serial number, test number, date, speed, volts, phase, impeller diameter, and certification number. This report shall then be submitted to the Engineer.

M. Pump Base and Guide Rails:

1. A separate mounting plate shall be furnished for each pump. These shall include guide rail supports and pump discharge elbow to align with hydraulic seal flange and pump discharge. Plates and fittings shall be coated with a tar base epoxy. Sealing face of discharge elbow shall be heavily coated with zinc to provide a smooth corrosion resistant surface. The carrier shall be designed such that lifting is done from the carrier and no strain is placed on the pump or guide rails.

2. The guide rails shall be 2 inch Schedule 40 stainless steel pipe. Each pump shall be furnished with 5/32 inch minimum diameter stainless steel cable for lifting out the pumps. The cable shall be of sufficient length and attach to the pump so as to provide a direct pull over the center of weight.

2.04 ELECTRICAL POWER AND CONTROL SYSTEM

A. The electrical and control system shall be as specified in Division 26.

2.05 PIPING

A. Exposed Ductile Iron (DI): Pipe shall meet the requirements of ANSI/AWWA C115/ A21.15; Class 53. Joint construction shall be flanged type with required bolts and full face gasket, meeting the requirements of ANSI/AWWA C111/ A21.11. Fittings shall be ductile iron, meeting the requirements of ANSI/ AWWA C110/A21.10. Where stainless steel bolts are used, they shall be installed with a heavy coating of anti-seize compound. Standard cement mortar lining shall meet the requirements of ANSI/AWWA C104/A21.04. All exposed ductile iron pipe shall be primed and painted in accordance with manufacturer recommendations and these specifications.

B. Buried Ductile Iron (DI). Pipe shall meet the requirements of ANSI AWWA C151/ A21.51; Class 52. Fully body fittings shall be ductile iron, meeting the requirements of ANSI/AWWA C110/A21.10. Compact fittings shall be ductile iron, meeting the requirements of ANSI/AWWA C153/A21.53. Standard cement mortar lining shall meet the requirements of ANSI/AWWA C104/A21.04. Joint construction shall be either push-on type or mechanical joint type (meeting the requirements of

ANSI/AWWA C111/A21.11). Push-on type shall be rubber gasket type slip joint; "Fastite", "Bell-Tite", "Tyton", or equal. Mechanical joints shall have plain rubber gaskets. Water pipe and other piping as designated shall receive conductivity straps. Metal wedges are not acceptable.

C. All buried ductile iron pipe and fittings shall receive polyethylene encasement. Polyethylene encasement shall be polyethylene film tube conforming to ANSI/AWWA C105/A21.5. Polyethylene film sheet conforming to ANSI/AWWA C105/A21.5 may be used at odd-shaped appurtenances where the use of tube is not practical. The polyethylene film shall be clearly marked with the information required in ANSI/AWWA C105/A21.5.

2.06 VALVES

A. All buried valves shall be furnished with extension stems which extend to within one foot of the finished grade elevation. The extension stem shall have a 2-inch operating nut and be mechanically connected to the valve operator. Furnish one valve operating key with the same required key length per every ten buried valves.

B. Buried valves shall have polyethylene encasement conforming to AWWA C105, Type I, 8 mil thickness.

C. All valves to be tagged with 1-1/2 inch diameter brass valve tags with 1/4 high black enamel filled letters. Each valve number shall consist of an identifying letter prefix with a maximum of five characters followed by a number with a maximum of four characters. Valve numbers to be supplied by Engineer.

D. Valve ends shall conform to ANSI B16.1, Class 125 flanges or mechanical joints to match the piping system.

E. Only manufacturers with a local state certified factory representative shall be allowed to supply equipment.

F. <u>Plug Valves:</u>

1. Plug valves shall be of the non-lubricated eccentric type with resilient faced plugs and shall be furnished with end connections as shown on the plans. Port areas for all valves shall be minimum 80 percent full pipe area for rectangular port, and 100 percent of pipe diameter area. Plug valves shall be Val-Matic, or equal.
2. Valve Bodies shall be of ASTM A126 Class B cast iron compliance with AWWA C504 Section 2.2. Bodies in 3 inch and larger shall be furnished with a welded overlay seat of not less than 90 percent pure nickel, minimum thickness of 1/8 inch and in accordance with AWWA C507 Section 7.2. Seat area shall be raised, with raised surface completely covered with weld to insure that the plug face contacts only nickel. Valves utilizing resilient seats attached to the body shall not be acceptable. As per AWWA C504 Section

35.2 and AWWA C507 Section 7.2, sprayed or plated seats are not acceptable, nor shall screwed-in seats be acceptable.

3. Plugs shall be of ASTM A126 Class B cast iron in compliance with AWWA C504, Section 2.2. The plug shall be of one-piece construction and shall be capable of withstanding the full pressure rating of the valve without the use of additional structural reinforcing ribs that extend beyond the profile of the plug itself. Plugs shall be resilient faced with neoprene or hycar, suitable for use with sewage. Plugs with cast inlays shall not be acceptable.

4. Valves shall have sleeve type metal bearings conforming to AWWA C504, Section 3.6 and AWWA C507, Section 8. Bearings shall be of sintered, oil impregnated and permanently lubricated type 316 ASTM A743 Grade CF-8M or AISI Type 317L stainless steel in 1/2 inch through 36 inch sizes. Grit seals shall be required in the upper and lower journals to protect the bearings. Non-metallic bearings shall not be acceptable.

5. Valve shaft seals shall be of the multiple V-ring type or U-cup and shall be externally adjustable or self-adjustable, repackable without removing the bonnet or actuator from the valve, and repackable under pressure. Shaft seals shall conform to AWWA C504, Section 3.7 and AWWA C507, Section 10.2. Valves utilizing O-ring seals shall not be acceptable. All exposed nuts, bolts, springs, washers, etc., shall be stainless steel for buried or submerged valves and zinc plated for all others.

6. Valve pressure ratings shall be 175 psi. Each valve shall be given a hydrostatic and seat test with test results being certified when required by the specifications. Valves shall provide driptight shut off with pressure in either direction.

7. Manual valves shall have enclosed worm gear actuators with seals and gaskets rated for corrosive, wet duty, stainless steel bolts and fasteners, tee wrenches, extensions stems, and supports. Worm gears shall be designed and certified to withstand input loads of up to 300 ft.lbs. minimum at the stops, without damage. Gear actuators shall be rated for bi-directional shutoff at the design pressure rating of the valve. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. The actuator shaft and the quadrant shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque. All exposed nuts, bolts, and washers shall be zinc plated.

8. Buried valves shall be furnished with solid cast iron or hot-dipped galvanized steel hollow shaft extension stems for increased corrosion resistance. Stems shall extend to within one foot of the finished grade elevation. The extension stem shall have a 2-inch operating nut and be mechanically connected to the valve operator. Minimum of two (2) wrenches for each plant site area (50 ft x 50 ft area) with buried valves. Valves shall include stainless steel stem guides at 5 ft O.C.

G. Check Valves:

1. Provide Swing-Flex Series 500, ASTM A536 Grade 65-14-12, Class B ductile iron body and cover, molded Buna-N (NBR) ASTM D2000-BG disc, flanges per ANSI B16.1, Class 125, interior and exterior coated with fusion bonded epoxy, manual operator, mechanical disc position indicator and backflow actuator as manufactured by Val-Matic, or equal.
2. The valve shall have a 150 psi rated body constructed of high-strength cast iron conforming to ASTM A126 Class B with integral flanges, faced and drilled per ANSI B16.1 Class 125 and be suitable for horizontal or vertical installation. Valve materials and construction certified for wastewater and sludge use.
3. The valve body shall be the full waterway type, designed to provide an open flow area not less than the nominal inlet pipe size when swung open no more than 25 degrees. The valve shall have a replaceable stainless steel body seat.
4. Valve disc shall be cast iron and faced with a renewable resilient seat ring of rubber or other suitable material, held in place by a follower ring and stainless steel screws.
5. The disc arm shall be ductile iron or steel, suspended from and keyed to an austenitic stainless steel shaft located completely above the waterway and supported at each end by heavy bronze bushings. The shaft shall rotate freely without the need for external lubrication. The shaft shall be sealed where it passes through the body by means of a stuffing box and adjustable packing. Simple o-ring shaft seals are not acceptable.
6. The valve shall be supplied with an outside lever and adjustable counterweight to initiate valve closure. Valve closure shall be dampened by means of a single, side-mounted, stationary, bronze air-cushion assembly directly mounted to the valve body on machined pads. The amount of cushioning shall be easily adjustable without the need for pre-charged air chambers.
7. The valve shall swing open smoothly at pump start and close quickly and quietly upon pump shutdown to prevent flow reversal. When closed, the valve shall seat drop tight.

2.07 PIPING IDENTIFICATION

A. Identify all process piping with its process designation and direction of flow; identify with semi-rigid, snap-on acrylic-plastic identification markers at 15 foot intervals, at each change of direction, and adjacent to each point it passes through a wall, floor or ceiling; comply with ANSI and OSHA pipe mark requirements.

B. Identify pipes less than 1 inch in diameter with brass tags, 1-1/2 inch in diameter with depressed 1/4 inch high black enamel-filled letters, securely fastened at 5 foot intervals.

2.08 PIPE HANGERS & SUPPORTS

A. Pipe hangers shall consist of ceiling flange threaded rod, and adjustable clevis type hanger constructed of carbon steel.

B. Vertical piping shall be supported at each floor and at intervals determined by the vertical load involved. Riser clamps shall be supported on spring hangers. Short risers shall include a saddle at the bottom and may require an additional hanger at the top. Longer risers may require over-sized U-bolts or similar devices to prevent lateral motion.

C. Pipe supports where ceiling mounted to concrete surfaces shall consist of a base flange, support rod with threaded ends for height adjustment, and a saddle type or stanchion type support as required.

D. Pipe supports shall be wall-mounted brackets where pipelines are located within 3-feet of walls. Maintain minimum of 7-foot clearance under supports.
   1. Provide U-bolt attachment, roller, or pipe saddle above the bracket.
   2. Where clearance is limited, suspend clevis hanger from wall bracket.
   3. Provide floor-mounted type support stands with adjustable pipe column, circular cradle, and floor attachment flange where wall or ceiling mount are not feasible and maintenance access will not be interrupted.

E. Install hangers and supports as required to support piping shown on plans; conform to American Standard Code for Pressure Piping, ANSI B31.1. Provide galvanized or stainless structural steel members required for supporting or anchoring piping and accessories.
   1. Exterior and underwater pipe supports shall be type 316 stainless steel.
   2. Pipe supports in wet atmosphere or corrosive chemical areas, shall be type 316 stainless steel.
   3. Interior room locations not subject to wet or corrosive conditions shall have pipe supports of hot-dipped galvanized steel construction.

F. Design and locate supports, anchors, rollers and guides and show on shop drawing submittal subject to acceptance of Engineer.
   1. Absence of pipe support and details on the drawings shall not relieve the Contractor of responsibility for providing supports.
   2. Maintain equipment maintenance clearance around all equipment and operator and equipment removal egress paths throughout all Rooms.

2.09 FIXTURE SUPPORTS

A. Wall hung fixtures, hanger plates, support arms or mounting lugs shall be fastened to the wall by through bolts where appearance of the bolts is not objectionable. Exposed bolt heads in finished areas shall be hexagonal and painted. Exposed nuts shall be chromium plated hexagonal cap nuts. Washers shall be painted or chromium plated to match bolt heads or nuts.

2.10 EXPANSION JOINTS

A. Expansion joints shall be of the bellow type with filled arches suitable for temperatures of minus 20 degrees F to plus 180 degrees F equipped with limit bolts to restrict maximum extension.

2.11 PIPELINE TAPS

A. Pipeline Tapping Saddles: Sizes ½ inch through 3 inch diameter, provide double-strap bronze body saddle with gasket and two stainless steel clamping bands, assembly rated for 150 psig. Provide saddles at all locations, unless indicated otherwise on the drawings.

2.12 PAINTING

A. All exposed metal piping, exposed fittings, all valves and bollards shall be painted. Stainless steel surfaces, code-required labels or equipment name, identification, performance rating, or nomenclature plates should not be painted.

B. Painting of all exposed piping, valves, and fittings shall be completed prior to start-up and performance testing of the lift station.

C. Submit product data for paint system. Product data shall include, but not be limited to, manufacturer's information on products intended use, application procedures, and material properties.

D. Paint System: the following system is based on Tnemec brand productions. Contractor may use alternate brands only if approved by the Engineer.

1. Shop surface preparation: Abrasive blast clean in accordance with SSPC-SP10 near-white blast cleaning standards. Apply primer before any rust bloom appears.
2. Shop prime coat: apply one even coat of Tnemec Series N69-Color at 3.0 to 5.0 mils DFT.
3. Field touch-up: spot blast in accordance with SSPC-SP10 near-white blast cleaning standards. Apply one coat of Tnemec Series N69-Color at 3.0 to 5.0 mils DFT.
4. Intermediate coat: apply one even coat of Tnemec Series N69-Color at 4.0 to 6.0 mils DFT.
5. Finish coat: apply one even coat of Tnemec Series N69-Color at 4.0 to 6.0 mils DFT.

PART 3 CONSTRUCTION METHODS

3.01 INSPECTION AND TESTING

A. Leakage is not permissible on any exposed line or any line that will be placed under pressure or suction. The Contractor shall at his own expense locate and repair the defective joints.

B. Inspection and testing requirements shall comply with City of Madison Standard Specifications, Part V – Sewers and Sewer Structures.

3.02 PUMP FIELD PERFORMANCE TEST

A. Each pump shall be tested after installation to check the guaranteed performance. The Contractor shall furnish and install all gauges and accessories required for this test and shall run each pump in the duplex system as directed by the Engineer. The Contractor shall provide field data taken from at least three different operating points for comparison with pump curves. The Contractor shall record the individual shutoff head for each pump for comparison with pump curves. The Contractor shall also record amp readings in each leg for each pump to check for motor imbalance and excessive amp draw by the motor. The Contractor shall be responsible for all adjustments or replacements necessary.

B. Any defects in the equipment or failure to meet the guarantees or requirements of the specifications shall be promptly corrected by the Contractor by replacements or otherwise. The decision of the Engineer as to whether or not the Contractor has fulfilled his obligations under the contract shall be final. If the Contractor fails or refuses to make these corrections or if the improved equipment, when tested shall again fail to meet the guarantees of the Contractor, the Owner, notwithstanding its ownership of work and materials which have entered into the manufacture of said equipment, shall have the option of rejecting said equipment or of accepting the same at such reduced price as may be agreed upon by the parties hereto.

3.03 INSTALLATION

A. From the time the lift station is delivered to site until final acceptance, the Contractor shall protect the lift station from flooding, freezing, or excessive humidity. If temporary electric power is necessary, that expense shall be borne by this Contractor. The Contractor shall make periodic inspections of the lift station to check for any possible problems including flooding or equipment failure. In the event of damage due to the Contractor failing to maintain the lift station as outlined above, all expenses necessary to restore the lift station in first class working order shall be borne by the Contractor.

B. After the job installation is completed, a qualified factory representative shall place the station in operation, conduct a complete functional check, and make all necessary adjustments for regular service. The Owner shall be given four complete operating

and maintenance manuals. Factory representative shall provide four man-hours of startup service and four hours of operator training. Factory representative shall provide four copies of certified station operation report.

3.04 GUARANTEE

A. The manufacturer of the lift station shall guarantee for one year from the date of start up that the entire station and all equipment therein shall be free from defects in design, materials and workmanship. In the event a component fails or is proven defective during the guarantee period, the manufacturer shall provide replacement parts without cost. The labor required to repair or replace major items including the structure, sewage pumps and/or motors, valves or fittings shall also be furnished without charge. The labor to replace accessory items such as the dehumidifier, sump pump, alternator, etc., that should become defective during this period, shall be provided by the Contractor. Normal use items such as grease, light bulbs, mechanical seals, packing and belts are excluded.

B. The station manufacturer shall maintain a permanent service station in the State of Wisconsin equipped with the necessary repair parts, shop and field service facilities, and trained personnel to guarantee continuous operation of this installation.

PART 4 MEASUREMENT AND PAYMENT

4.01 PACKAGE LIFT STATION

A. Lift Station will be paid for on a lump sum basis at the contract price. Price shall be paid in full for all excavation, bedding, by-pass pumping, back filling, compaction, testing, startup, and furnishing of all materials, fittings, tools, equipment, labor and incidentals necessary to complete the work in accordance with the contract documents. Electrical connection to utility, back-up generator, fencing, and all valves and piping necessary for proper lift station functionality shall be included in the lump sum price.

B. All Dewatering required for lift station construction shall be included in the trench dewatering bid item.

END OF SECTION

SECTION 33 51 13

NATURAL-GAS PIPING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Natural gas piping from meter to generator as specified herein, and as needed for a complete and proper installation including, but not necessarily limited to:
   1. Gas service.
   2. Piping, fittings, valves, regulators, appurtenances, etc.
   3. Mechanical Identification. Sleeves.
   4. Caulking of penetrations, openings, and fixtures.

B. Coordinate service, with required meter, with local gas utility.
   1. Verify gas service pressure at connection.
   2. Coordinate installation of concrete pad for gas service.

1.02 RELATED SECTIONS

A. Documents affecting work of this section include, but are not necessarily limited to, General Conditions, Supplementary Conditions, and Sections in Division 01 of these specifications.

B. Division 31 – Earthwork: Requirements for trenching and backfilling.

1.03 WORK OF OTHER SECTIONS

A. Openings for work in walls, floor, roof, ceiling, etc., required by this section shall be provided under other sections. Locations and size of these openings shall be the responsibility of this Contractor.

B. Division 03 - Concrete.

C. Division 07 – Joint Sealeants

D. Division 09 – High Performance Coatings

E. Division 26 - Electrical

1.04 GENERAL PROVISIONS

A. Everything essential for the completion of the work implied to be covered by these Specifications to make the System ready for normal and proper operation must be furnished and installed by the Contractor. Accordingly, any omission from either the plans or the Specifications, or both, of details necessary for the proper installation

and operation of the system shall not relieve the Contractor from furnishing such detail in full and proper manner.

B. The plans show various details indicating the general arrangement of the gas piping work, sizes and locations of piping, etc. The said plans with figures, lettering, etc., shall be considered a part of these Specifications and no charge or alternation shall be made in either case unless ordered by the Engineer.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with State of Wisconsin and industry standards.

B. Qualification of Installer:
   1. Company specializing in performing the work of this section with minimum three (3) years documented experience.
   2. In acceptance or rejection of installed work, the Architect or Engineer shall make no allowances for lack of skill on part of the installers.
   3. Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
   4. All work shall be installed in a first class manner by State of Wisconsin licensed plumbers.

C. Qualification of Manufacturer:
   1. Company specializing in manufacturing products specified in this section with a minimum of 10 years experience. Manufacturer shall conform to the ratings and certifications indicated.
   2. Equal products shall be of similar quality, be functionally similar, and have the controls specified. Where more than one type of product is specified in a particular section, the listed acceptable manufacturers may not have an equal product for every type of product specified.

D. Codes and regulations:
   1. In addition to complying with the specified requirements, comply with pertinent regulations of governmental agencies having jurisdiction.
   2. In the event of conflict between or among specified requirements and pertinent regulations, the more stringent requirement will govern when so directed by the Engineer.

E. The following standards, referred hereafter by basic designation only, are imposed, as applicable to work in each instance, and form a part of this specification to the extent indicated by the reference thereto:
   1. ANSI - American National Standards Institute
   2. ASME - American Society of Mechanical Engineers
   3. ASTM - American Society for Testing and Materials

1.06 COORDINATION

A. Cooperate and coordinate with other trades to assure that all systems in the work may be installed in the best arrangement. Coordinate as required with all other trades to share space in common areas and to provide the maximum of access to each system.

B. Locate equipment properly to provide easy access, and arrange entire work with adequate access for operation and maintenance.

C. Give right-of-way to piping which must slope for drainage.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Accept valves, regulators, etc., on site in factory packaging. Inspect for damage.

1.08 CLOSEOUT SUBMITTALS

A. Section Project Closeout: Closeout provisions.

B. Project Record Documents and As-Builts: Record actual location of equipment and fixtures including items remotely within walls or above ceilings, etc.

C. Operation and Maintenance Data and Instructions:
   1. Submit manufacturer's descriptive literature, operating instructions, service instructions, installation instructions, maintenance and repair data, parts listing, warranties, and wiring diagrams.
   2. Assemble two (2) complete sets. Prepare in bound copies complete with index tabs.
   3. Submit bound copies to Engineer for disbursement.

1.09 SPECIAL PROJECT CONDITIONS

A. Allowances:
   1. Section 01 21 00 – Allowances.
   2. The allowance amount shown is the invoice amount from the utility.
   3. The plumbing contract will be adjusted up or down by change order by the amount listed for the allowance, less the actual cost of the utility fee. No additional compensation for mark-ups or handling will be allowed by the contractor. Any such costs shall be included in the bid.

B. Utility Coordination:
   1. Be responsible for utility coordination on behalf of the Owner.

PART 2 PRODUCTS

2.01 PIPES AND TUBES

A. Natural Gas Piping:
   1. Piping and tubing shall have a minimum working pressure of 150 psig.
   2. Buried beyond below the building and outside within 5 feet of building:
      a. By gas utility.
      b. Polyethylene Pipe: ASTM D2513, SDR 11.5, with socket type fittings and fusion welded joints.
      c. Materials and installation shall conform to AWWA C203 requirements.
   3. Above ground:
      a. Steel Pipe: ASTM A53, Schedule 40 black, with malleable iron or forged steel fittings, screwed or welded. Threaded joints shall comply with ASME B1.20.1.
      b. Equipment Connections:
         1) Flexible connector, minimum 12-inch long.
         2) Tested and listed in compliance with the construction, installation, and performance requirements of ANSI/AGA LC 1.
         3) Tubing joints: Shall be made with approved gas tubing fittings or brazed with a material having a melting point in excess of 1,000^{o} F. Brazing alloys shall not contain more than 0.05% phosphorus.

2.02 VALVES

A. Valves must be trademarked on body with manufacturer's name or trademark and pressure rating.

B. Minimum design pressure of 200 psig and certified for water-oil-gas (WOG) operation.

C. Gas shut-off valves:
   1. Ball valve: bronze body, threaded ends, stainless steel ball, full or conventional port, Teflon seat, blow-proof stem, two-piece construction.
   2. UL listed for use as a gas shut-off.
   3. Acceptable Manufacturers: American Valve, Red-White Valve Corp., or equal.

D. Gas Cocks:
   1. Sizes 1/2 inch to 4 inches: DeZurik Fig. 425 gas valve, cast iron body, screwed or flanged ends, bronze bearings, bronze plug and resilient seal ring for bubble-tight shut-off to 175 psig working pressure.
   2. UL approved for natural gas.

3. Acceptable manufacturers: Crane, DeZurik, Jenkins, Milwaukee, Nibco, and Walworth.

2.03 PIPING SPECIALTIES

A. Flanges, Unions, and Couplings:
   1. Pipe Size 2 inches and Under: Malleable iron unions for threaded ferrous piping; bronze unions for copper pipe, soldered joints.
   2. Grooved and Shouldered Pipe End Couplings: Malleable iron housing, C-shape elastomer composition sealing gasket, steel bolts, nuts, and washers.
   3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

B. Gas Regulators:
   1. Sizes 3/4 inch to 2 inch: Quick reacting with internal relief for overpressure protection, self-operated regulation with cast iron body, relief, spring steel case, and Nitrile diaphragm.
   2. Regulators shall reduce gas supply line (PSIG) pressure to equipment operating pressure (W.C.). Verify supply line pressure with Gas Utility. Verify equipment operating pressure with manufacturer.
   3. Gas regulators shall be sized for pressure and flow requirements for all of the equipment it serves.
   4. Acceptable manufacturers: Fisher, Leslie, Maxitrol, Nibco and Spence.

2.04 SLEEVES

A. Sleeves: 18 gage thick galvanized steel

B. All sleeves shall be of sufficient diameter such that the bare pipe with unbroken pipe covering or wrapping, where specified, can pass through and allow for expansion and contraction in all directions.
   1. Sleeve shall be two pipe sizes larger than the pipe passing through; or provide a minimum of 1/2 inch clearance between inside of sleeve and outside of the pipe.

2.05 MECHANICAL IDENTIFICATION

A. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, UV resistant and stable, preformed to fit around pipe or pipe covering. Larger sizes may have a minimum sheet size with stainless steel spring fastener. Minimum width of 3 inches, to comply with State of Wisconsin Plumbing Code. Color and Lettering: Conform to ASME A13.1 and State of Wisconsin Plumbing Code.
   1. Acceptable Manufacturer: Seton Nameplate Corporation, Kolbi Pipe Markers Co., or equal.

B. Plastic Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

C. Valve Tags: minimum 1 1/2 inches diameter, lettering shall be a minimum of 1/2 inch in height.
   1. Material:
      a. Brass.
   2. Shape:
      a. Gas Service: Square/diamond shape.

PART 3 EXECUTION

3.01 JOB CONDITIONS

A. Surface Conditions: Examine the areas and conditions under which work will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

B. Measurements:
   1. Field measuring existing conditions.
   2. Lay out work, properly locate all apparatus, pipe, fittings, sleeves, etc. Adjust work, as necessary, to insure that work shall fit into the spaces that have been allotted for such work. Due regard shall be taken for the work of other trades.

3.02 SYSTEM LAYOUT

A. Lay out the system in careful coordination with the Drawings; determine proper elevations for all components of the system and using only the minimum number of bends to produce a satisfactorily functioning system.

B. Follow the general layout shown on the Drawings in all cases, except where other work may interfere.

3.03 TRENCHING AND BACKFILLING

A. Perform trenching and backfilling associated with the work of this Section in strict accordance with the provisions of Division 31 of these Specifications.

3.04 SERVICE CONNECTIONS

A. Install gas service complete with gas meter and regulators. Verify gas utility pressure at building service connection. Install regulators on each line serving gravity type appliances, sized in accordance with equipment.

3.05 INSTALLATION – SLEEVES

A. Sleeves shall be fastened securely in place.

B. Section 07 92 00: Caulk the space between the sleeve and pipe.

3.06 INSTALLATION - PIPE

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside piping before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.07 INSTALLATION - PIPING SYSTEMS

A. Install dielectric connections wherever jointing dissimilar metals.

B. Install unions downstream of valves and at equipment connections.

C. Route piping parallel to structure and maintain gradient.

D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

E. Thoroughly clean items before installation.

F. Cut pipe accurately, and work into place without springing or forcing. Excessive cutting or other weakening of the building will not be permitted.

G. Install piping, valves, and other items to permit access for maintenance. Relocate items as necessary to provide such access, and without additional cost to the Owner.

H. Install identification on piping systems, including underground piping.

I. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

J. Make changes in directions with fittings; make changes in main sizes with eccentric reducing fittings.

K. Pipe Joints:
   1. Screwed Piping:
      a. Deburr cuts.
         1) Do not ream exceeding internal diameter of the pipe.
         2) Thread to requirements of ANSI B2.1.
      b. Use Teflon tape on male thread prior to joining other services.

c. Use litharge and glycerin on joint prior to cleaning for air and oil piping.

2. Leaky Joints:
   a. Remake with new material.
   b. Remove leaking section and/or fitting as directed.
   c. Do not use thread cement or sealant to tighten joint.

3.08 INSTALLATION - VALVES

A. Install valves with stems upright or horizontal, not inverted.

B. Install valves for shut-off and to isolate equipment.

3.09 INSTALLATION - FUEL PIPING

A. Install natural gas piping in accordance with NFPA 54.

B. Provide clearance for installation of and access to valves and fittings.

C. Establish elevations of buried piping outside building to provide not less than 18-inch of cover.

D. Provide support for utility meters in accordance with requirements of utility company.

E. Terminate vent from gas pressure reducing valves or regulators per manufacturer's instructions.

3.10 INSTALLATION - MECHANICAL IDENTIFICATION

A. Install adequate marking of exposed accessible piping, per ANSI A13.1.

B. Install tags with corrosion resistant metal chain.

C. Valves:
   1. Tag all valves.

D. Pipes:
   1. Install pipe markers on all pipes.
   2. Space no more than 25 feet apart, with a minimum of one marker on each straight section of pipe.
   3. Color of bands:
      a. Gas Pipe: Red

3.11 PAINTING

A. Section 09 96 00: All exposed piping, fittings, valves, etc., without factory finish or finished cover, shall be painted.

B. Touch-up all factory finishes damaged during construction.

3.12 TESTING AND ADJUSTING

A. Section 01 77 00 - Closeout Procedures: Testing and adjusting provisions.

B. Contractor shall notify any inspectors required to observe test, when test is ready to be performed. Contractor shall advise A/E field representative that notification has been given.

C. All equipment required for testing, including fittings for additional openings, shall be provided by Contractor. Contractor shall provide all personnel required for testing. Contractor shall pay the cost of all required tests and retests and inspections if required.

D. Tests shall be witnessed and approved by Owner's representatives and A/E field representative. Contractor shall certify in writing the time, date, name, and title of person approving test. This shall also include the description and what portion of the system has been approved. Person approving test shall sign certification.

E. A complete record shall be maintained of all testing that has been approved, and shall be made available at the job site to all authorities concerned.

F. Upon completion of the work, all records and certifications approving testing requirements shall be submitted to the A/E Field Representative before final payment is made.

G. Test natural gas piping in accordance with NFPA 54.

H. Notify A/E in advance regarding time and date of all tests.

I. Defective work or material shall be replaced or repaired, as necessary, and the inspection and test repeated. Repairs shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

J. Adjust the system to optimum standards of operation.

3.13 CLOSEOUT OPERATIONS

A. Closeout Equipment/System Operations: Sequence operations properly so that work of the project will not be damaged or endangered.
   1. Adjust and correct operations as required for proper performance.

2. Clean each system: After all equipment has been proven operational, carefully clean all accessible parts, thoroughly removing all traces of dirt, oil, grease, and foreign substances.

B. Record Drawings.

3.14 SCHEDULE OF MECHANICAL IDENTIFICATION

A. Piping:
1. Natural Gas: “Natural Gas” or “Gas”

END OF SECTION